EPA/540/2-89/032

SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

Environmental Science and Engineering, Inc. "Final Report, Phase I - Immediate Assessment, Acme Solvents Site." Technical report of approximately 40 pp. submitted to the Acme Solvents Technical Committee. November 1985.

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Superfund Treatability Clearinghouse - EZYN

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Thermal Treatment - Incineration
Media:	Soil/Generic
Document Reference:	Environmental Science and Engineering, Inc. "Final Report, Phase I - Immediate Assessment, Acme Solvents Site." Technical report of approximately 40 pp. submitted to the Acme Solvents Technical Committee. November 1985.
Document Type:	Contractor/Vendor Treatability Study
Contact:	David Favero U.S. EPA - Region V 230 South Dearborn Street Chicago, IL 60604 312-386-4749
Site Name:	Acme Solvents Site (NPL)
Location of Test:	Rockford, IL

BACKGROUND INFORMATION: This is a site assessment and feasibility study of incineration alternatives at the ACME Solvents Site at Rockford, Illinois. The document contains laboratory results that are reported to simulate incineration conditions but no details on test methods were provided.
OPERATIONAL INFORMATION: The document summarizes the geophysical investigation, the delineation of the contaminated zones and their volumes and the sampling locations. Out of 43 samples taken at 18 locations, 20 were selected to be sent to an environmental laboratory for analysis of percent moisture (volatiles), percent ash, total chloride, total sulfur, Btu value and total PCBs. Two samples were analyzed for organic priority pollutants, pesticides and PCBs. No details on test methods were provided. Details on the soil matrix of each sample were summarized (the majority are silty soil). The ash from each of the 20 samples was analyzed for EP toxic metals. The data from these 20 samples is summarized as well as the more complete analysis results from the two samples.

This basic data was used in an analysis of feasibility, costs and relative merits of off-site and onsite incineration of the contaminated site material. Specific alternatives are costed for an onsite rotary kiln and an off-site rotary kiln.
PERFORMANCE: The laboratory test on the soil for EP toxicity showed the resulting ash/decontaminated soil was consistently well below EPA limits for hazardous wastes classification. Heavy metal levels in the decontaminated ash ranged from a high of 2.26 mg/l for Cr to a low of less than .009 mg/l for Se. All were well below the EP toxicity levels defined in 40 CFR 261.4 except for chromium which is about 50% of the allowed EP toxicity level of 5 mg/l. PCBs were reduced from 3600 to less than 4 ug/kg dry. There are no details provided on the laboratory incineration process, sampling protocols, QA/QC protocols or conclusions.

The economic analysis comparing onsite and off-site incineration showed onsite incineration could be accomplished at one-third the cost and with the same implementation time as the off-site incineration.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	12674-11-2	PCB-1016
	11096-82-5	PCB-1260
W05-Halogenated Cyclic Aliphatics/Ethers/ Esters/Ketones	57-74-9	Chlordane
	58-89-9	Gamma-BHC(Lindane)
W08-Polynuclear Aromatics	83-32-9	Acenaphthene
	91-20-3	Naphthalene
	85-01-8	Phenanthrene
	86-73-7	Fluorene
W09-Other Polar Organic Compounds	117-81-7	Bis(2-ethyhexyl)phthalate
	85-68-7	Butylbenzylphthalate
	84-74-2	Di-n-butylphthalate
	117-84-0	Di-n-octylphthalate
	78-59-1	Isophorene
	108-95-2	Phenol
W10-Non-Volatile Metals	7440-39-3	Barium
W11-Volatile Metals	7439-92-1	Lead
	7439-97-6	Mercury
	7440-22-4	Silver
	7440-43-9	Cadmium

Dave Tavers
8/27/87
E5

980-TS1-RT-EZY1

FINAL REPORT
PHASE I IMMEDIATE ASSESSMENT
ACME SOLVENTS SITE

Submitted to:

THE ACME SOLVENTS TECHNICAL COMMITTEE

Submitted by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
St. Louis, Missouri

85-841

November 20, 1985

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1.0 DESCRIPTION OF FIELD ACTIVITIES/METHODOLOGY

The final scope of field activities was defined via telephone conversations between ESE and representatives of the Acme Solvents Steering Committee. A work plan, sampling plan, and health and safety plan were developed and revised concurrently with the mobilization for the field effort. The field activities included the following:

1. Establishing a site grid;
2. Performing ground penetrating radar (GPR), magnetometer, and terrain conductivity surveys; and
3. Performing a boring and soil sampling program.

Boring logs and analytical results are presented in Appendices A and B, respectively.

1.1 GEOPHYSICAL INVESTIGATION

The grid established by E.C. Jordan for their RI effort was found and re-marked in order to perform the geophysical surveys.

1.2 SOIL SAMPLING

Based on results obtained during the GPR survey and the distribution of the mounds, a series of 18 boreholes were located at the site. All sample locations were further screened using a magnetic gradiometer and metal detector to avoid the safety and mechanical hazards of drilling into buried drums. Acceptable locations were limited due to the large amount of metallic signatures detected with these instruments, however a representative coverage of the "mounds" and surrounding areas of concern was established.

Samples were collected using a standard 24-inch split-spoon sampler. The split-spoon was driven at 2-foot intervals into bedrock until refusal was encountered. At each location, the sample was removed from

the sampler, placed on a sheet of aluminum foil, and divided into sections when appropriate. The sections were measured for total organic vapors then wrapped in foil and labeled for later reference (i.e. split-spoon number three was labeled SS-3; if there were more than one soil/waste layer per split-spoon they were labeled SS-3A, SS-3B, SS-3C, etc.). All labeled and wrapped core sections were kept chilled in coolers. The entire core material at the end of sampling at each location was composited according to visual characteristics and total organic vapors. The composited samples were labeled and placed in wide-mouth glass jars with Teflon-lined lids and packed on ice in coolers. Bedrock was sealed from borehole contamination by pouring granular bentonite downhole to at least 2 feet above the soil/bedrock interface. A granular bentonite cap was installed at the top of the borehole to prevent downhole contamination.

Decontamination took place between each borehole location. All augers, drilling rods, tools, and split-spoon samplers were pressure washed with a steam cleaner. The split-spoons were steam cleaned a second time on a separate decontamination pad, then left to air dry before assembling. The water used for decontamination was analyzed for TOC and TOX. The values obtained were 72.1 mg/l TOC and 20 ug/l TOX.

During sampling, the ESE Site Safety Officer and one ESE team member were continually monitoring with explosimeter and photoionization detectors. When handling the samples, respirators were worn by ESE team members whenever the photoionization meter detected organic vapors exceeding 1 ppm. The drillers generally would begin drilling without respirators and put on respirators when photoionization readings exceeded 1 ppm in their breathing zone.

2.0 DATA SUMMARY

2.1 GEOPHYSICAL INVESTIGATION

Figures 2-1, 2-2, and 2-3 represent the data, plotted on the map grid, obtained by GPR, terrain conductivity, and magnetometer, respectively.

The GPR survey lines are shown on Figure 2-4. Survey lines were not run completely across the mounds. The GPR antenna must be pulled behind a vehicle. Instead, the antenna was placed by hand up on the mounds and pulled down the slopes. In all cases, there was no penetration until the antenna reached the base of the mounds. The GPR did identify other areas of buried solid materials and areas containing liquid contamination. The areas of buried solid materials agree well with the magnetometer survey and are likely to contain metallic materials. The areas containing liquid and/or sludge contamination (outside of the mound areas) shown on Figure 2-1 reside in the dolomite bedrock at depth ranging from 20 to 28 feet below the surface, above a layer that is presumed to be less permeable (fractured). In some of the more highly contaminated areas, the contamination has followed fracture lines below the less permeable bedrock layers.

The terrain conductivity measurements generally were higher in the areas of the mounds and other burial areas where metal is suspected. The two main areas of high measurements, other than the mounds, are a drum burial area between lines B and C at 9+00 to 10+00 and the area between C and D at 8+00 to 10+00 which both GPR and magnetometer show as an area where there is buried metal (see Figure 2-2). The lack of conductivity anomalies in the mounds between end lines A and C and 4+00 and 5+00 is puzzling in that the GPR could not penetrate these mounds either, and the boring program indicated that sludges are present.

The magnetometer survey indicates the burial of metallic materials at various locations around the site. Generally the locations were

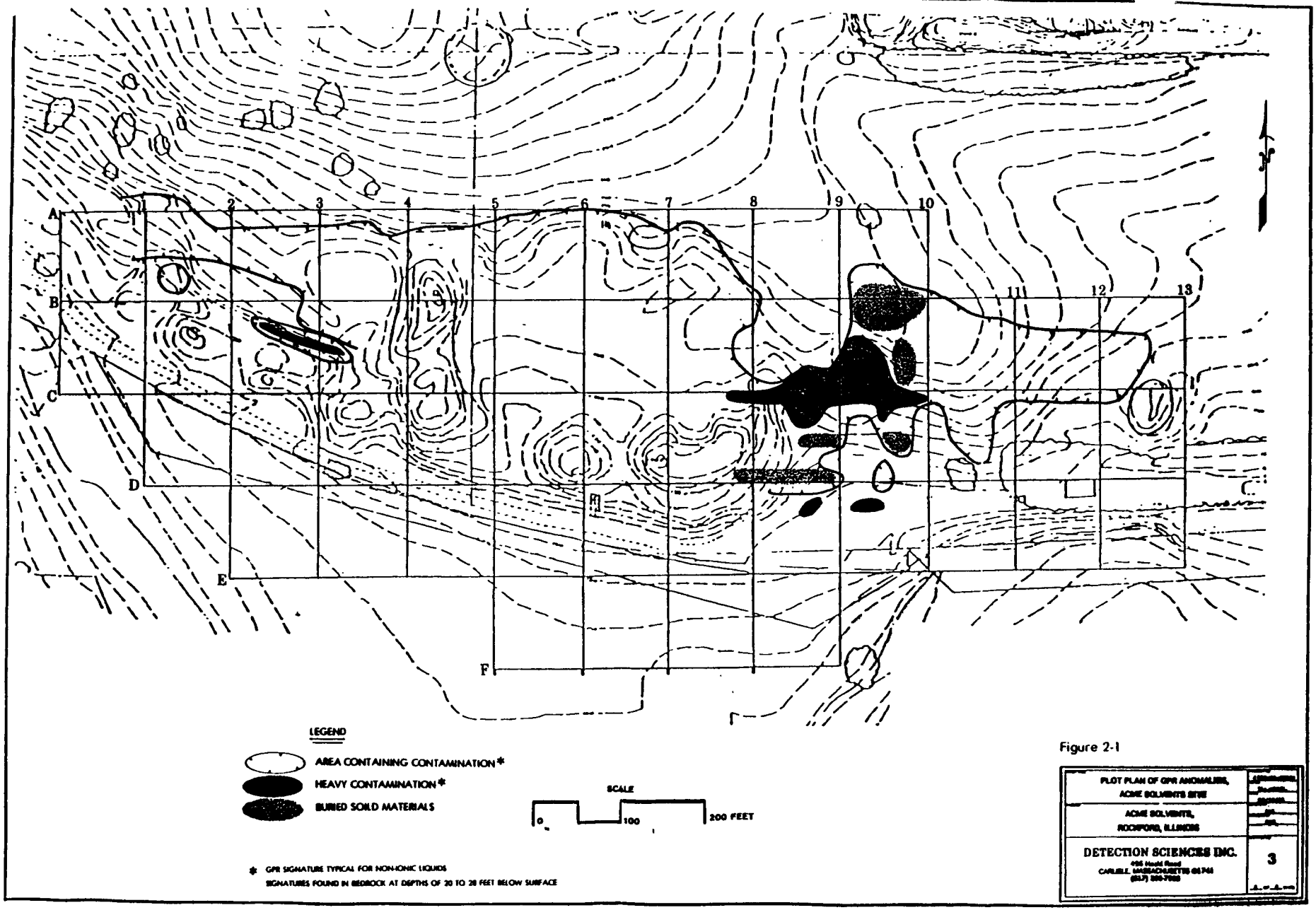

Figure 2-1

PLOT PLAN OF GPR ANOMALIES, ACME SOLVENTS SITE	
ACME SOLVENTS, ROCKFORD, ILLINOIS	
DETECTION SCIENCES INC. [illegible] CARLISLE, MASSACHUSETTS 01741 (617) 369-7988	3

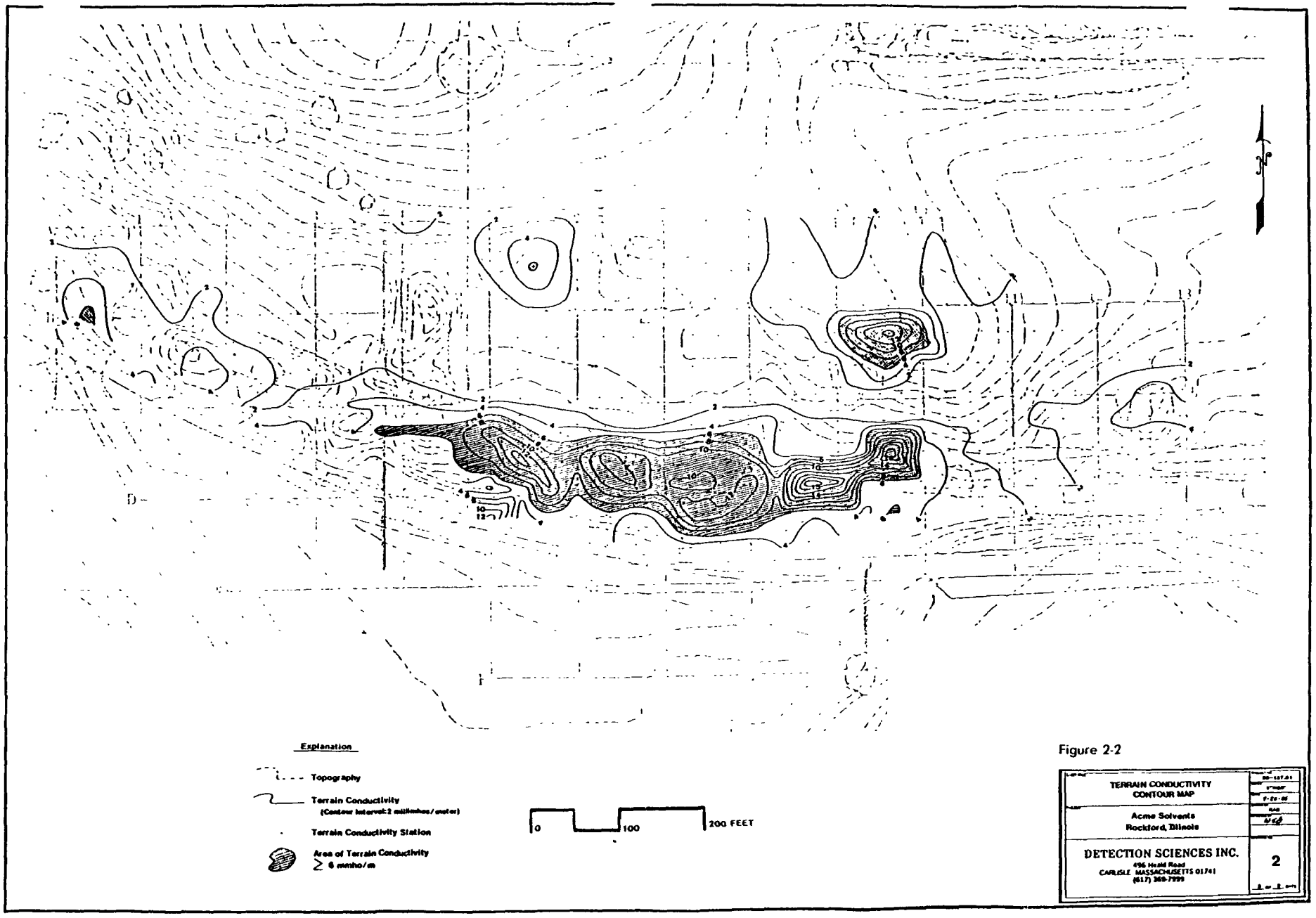
Explanation
Topography
Terrain Conductivity
(Contour Interval: 2 millimhos/meter)
Terrain Conductivity Station
Area of Terrain Conductivity
≥ 6 mmho/m
0
100
200 FEET
TERRAIN CONDUCTIVITY
CONTOUR MAP
Acme Solvents
Rockford, Illinois
DETECTION SCIENCES INC.
496 Heald Road
CARLISLE, MASSACHUSETTS 01741
(617) 369-7999
2

Figure 2-2

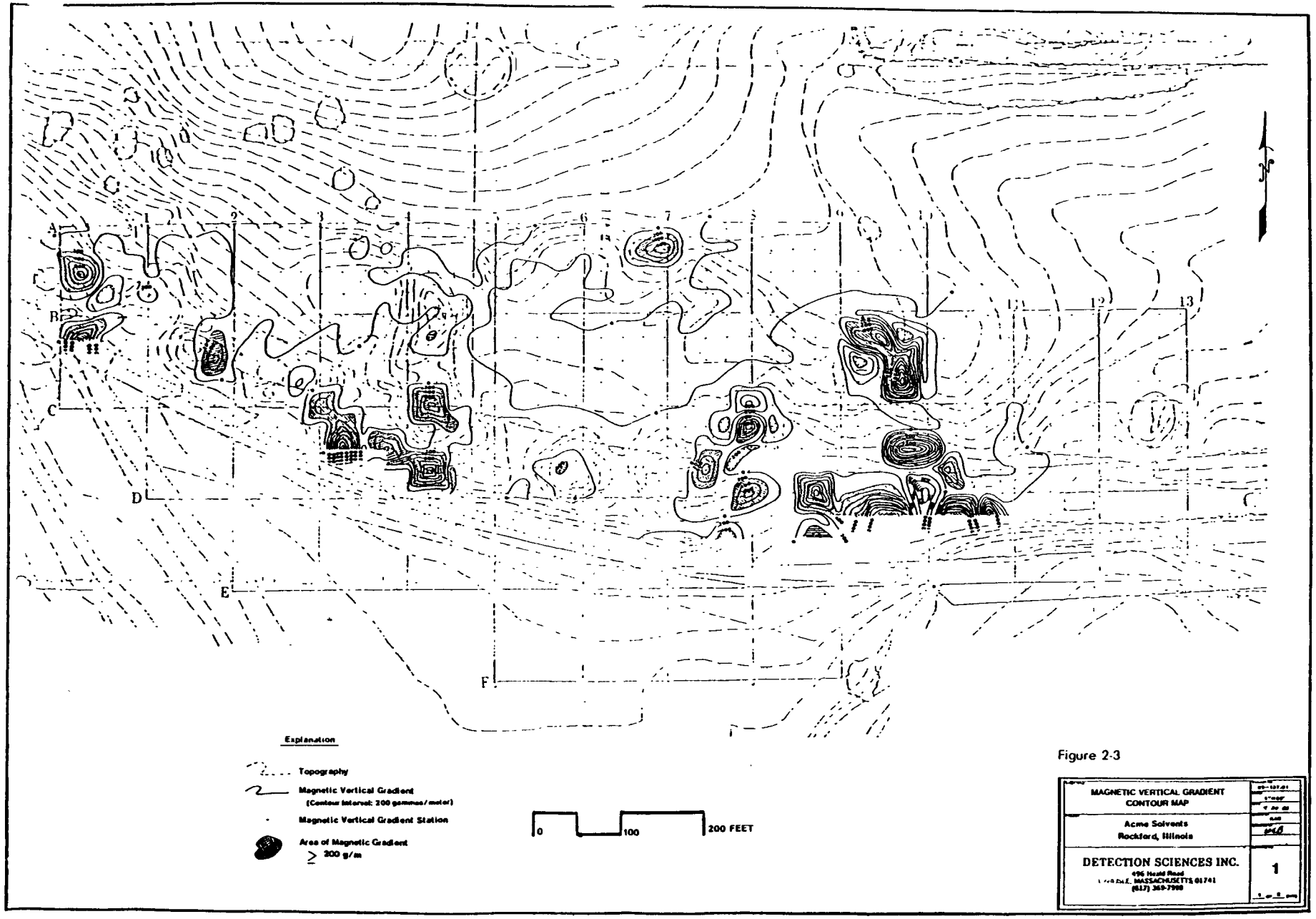
A
B
C
D
E
F
1
2
3
6
7
12
13
Explanation
Topography
Magnetic Vertical Gradient
(Contour Interval: 200 gammas/meter)
Magnetic Vertical Gradient Station
Area of Magnetic Gradient
≥ 200 g/m
0
100
200 FEET
MAGNETIC VERTICAL GRADIENT
CONTOUR MAP
Acme Solvents
Rockford, Illinois
DETECTION SCIENCES INC.
496 Hood Road
MASSACHUSETTS 01741
(617) 369-7998
1

Figure 2-3

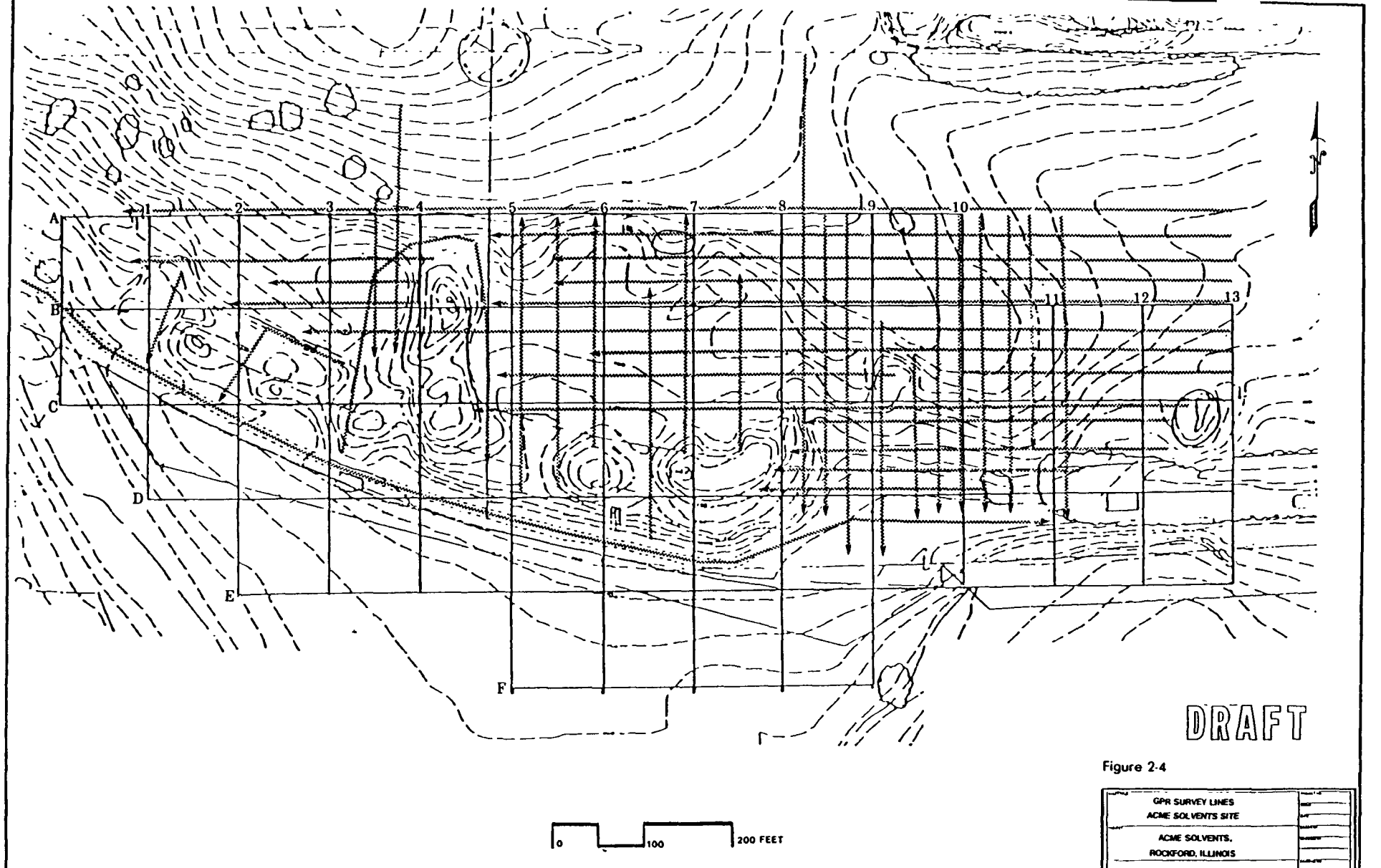

Figure 2-4

GPR SURVEY LINES ACME SOLVENTS SITE	
ACME SOLVENTS, ROCKFORD, ILLINOIS	
DETECTION SCIENCES INC. 496 Heald Road CARLISLE, MASSACHUSETTS 01741 (617) 369-7999	4

compatible with the GPR data. Contour lines in some areas are incomplete due to interference caused by either fence lines or power lines. Symmetry of these areas was assumed to calculate total area.

2.2 SOIL ANALYSES

A total of 43 soil samples from 18 locations were obtained. Eleven of the borings were located on the mounds, and multiple samples (between two and four) were taken from each location (Figure 2-5). A summary of the samples obtained are given in Table 2-1. Of these samples, 20 were sent to Environmental Analysis, Inc. (EA) for analysis of percent moisture (volatiles), percent ash, total chloride, total sulfur, Btu value, and total PCBs. The ash from each of the 20 samples was analyzed for EP Toxic metals. These results are presented in Table 2-2. In addition, two samples (B4B-02 and C6B-02) were analyzed for EP toxic metals and organic priority pollutants and the ash from these two samples were being analyzed for organic priority pollutants with the exception of volatiles. Results from these two samples are presented in Table 2-3. We have repeated the results of EP toxic metals for the ashes for these two samples in the table, for comparison purposes.

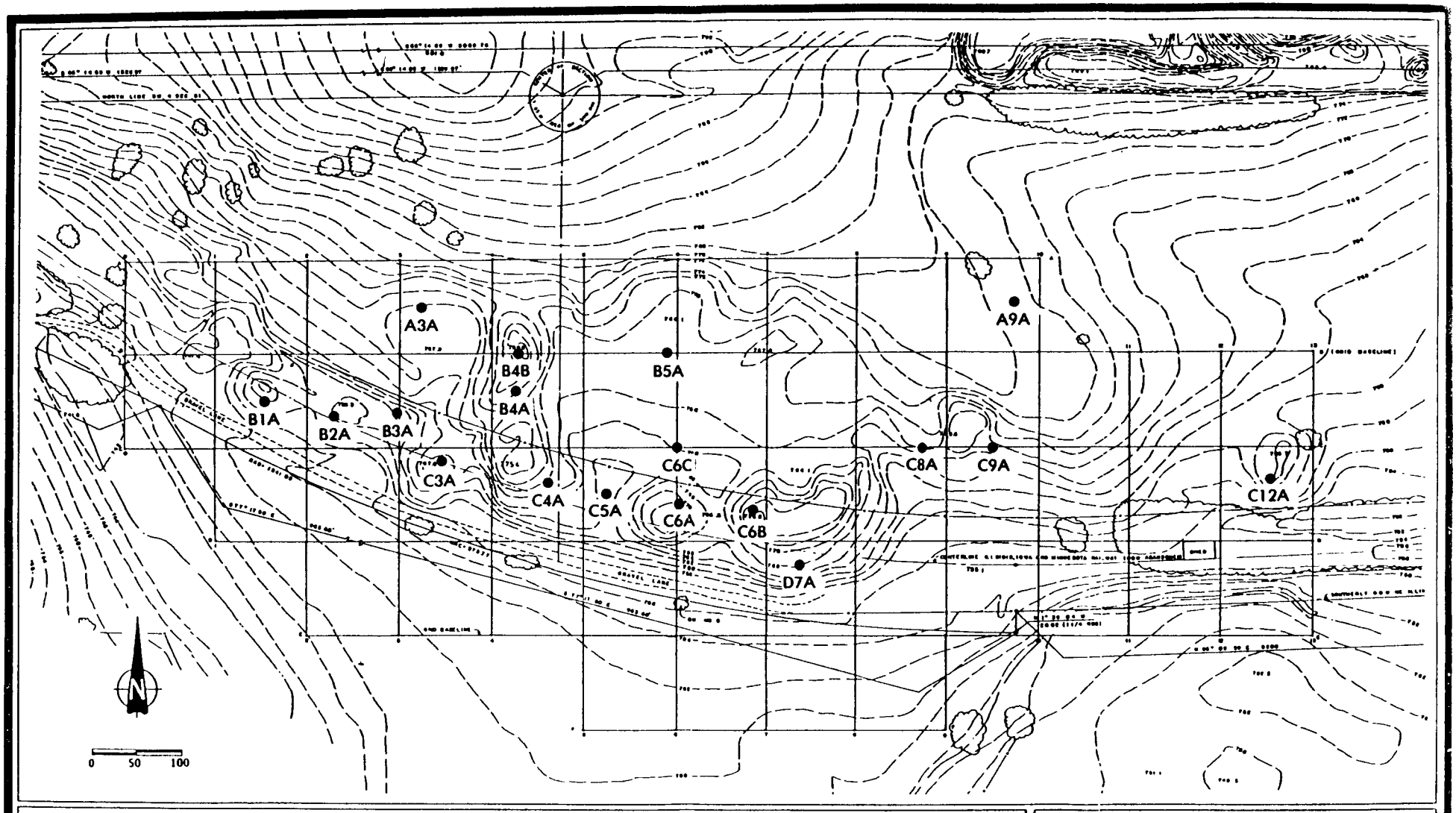

Figure 2-5
BOREHOLE LOCATIONS
ACME SOLVENTS

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

3.0 DETERMINATION OF ELEVATED CONTAMINATION ZONES AND INCINERATION OPTIONS

Table 2-1. Summary of Borehole Logs

Borehole Number	Borehole Sample Number	Depth Interval (feet)	Description	Remarks
B4A	B4A-01	0-4.0	Dark brown silt and fine to medium sand, slight fine gravel, small piece of light gray sludge	Fill, very slight sludge. HNU = 20 ppm on sludge.
	B4A-02	4-8.0	Black to brown silt and sand slight rust/brown staining, slight dark gray dry sludge	Fill, slight sludge. HNU = 100 ppm on sludge.
	B4A-03	8-13.2	Light brown, brown, green/gray sand, slight silty, slight gravel	Fill, no visible sludge. HNU at background.
B4B	B4B-01	0-6.0	Brown silt, sand, fine gravel, very slight possibly dark gray sludge	Fill, very slight possible sludge. No HNU reading.
	B4B-02	6-13.5	Brown sand and gravel, dark gray wet sludge, sand saturated with solvent and slight blue pigment 10-13.5'	Fill, sludge, pigment. HNU range 50 to 120 ppm.
C4A	C4A-01	0-4.0	Brown clay, silt, slight sand, some dolomite fragments, occasional gravel	Fill, no visible contamination. HNU at background.
	C4A-02	4-9.5	As above, slight gray sludge saturation	Fill, slight sludge. HNU = 80 to 100 ppm.
	C4A-03	9.5-12.2	Weathered dolomite bedrock, highly fractured	Bedrock. HNU = 10 to 30 ppm
C6A	C6A-01	0-7.8	Brown silt, fine to coarse sand, slight gravel, occasional dolomite fragments, some staining	Fill, some staining. HNU = 1 to 3 ppm.
	C6A-02	7.8-12.8	Silt, fine sand, gray sludge	Fill, sludge. HNU = 200 to 300 ppm on sludge.
	C6A-03	12.8-14.2	Weathered dolomite bedrock	Bedrock.

Table 2-1. Summary of Borehole Logs (Continued, Page 2 of 4)

Borehole Number	Borehole Sample Number	Depth Interval (feet)	Description	Remarks
C6B	C6B-01	4-8.0	Silt, fine sand, slight gravel, moist, slight black staining, lighter fluid odor	Fill, slight staining. HNU = 3 to 30 ppm.
	C6B-02	8-14	Silt, sand, slight gravel, gray staining, solvent saturation, slight gray sludge	Fill, slight sludge and staining. HNU = 50 to 100 ppm.
	C6B-03	16-18.3	Silty sand with slight gravel, possibly native, stained gray in areas, very moist	Possibly native material, slight staining. HNU = 30 ppm.
	C6B-04	18.3-21.1	Brown fine to medium sand, moist, dolomite fragments, igneous erratic	Possibly native material, bedrock. HNU = 5 to 10 ppm.
D7A	D7A-01	0-10.0	Brown silt, fine sand, occasional fine to medium gravel, saturated in areas	Fill, solvent, oil, paint odors. HNU = 2 to 60 ppm.
	D7A-02	10-16.0	Brown silt, fine sand, occasional fine to medium gravel, pieces of red, yellow, green, blue pigments/sludge	Fill, pigments, sludge. HNU = 60 to 210 ppm.
	D7A-03	18-21.0	Fine to coarse sand, fine to medium gravel, occasional rock fragment, slight gray sludge	Fill, slight sludge. HNU = 5 to 50 ppm.
	D7A-04	21-22.0	Weathered dolomite bedrock	Bedrock. HNU = 5 ppm.
C5A	C5A-01	0-6.0	Very dark brown fine sand, some silty layers, occasional dolomite fragment, moist	Fill, no visible contamination. HNU at background.
	C5A-02	6-9.6	Brown silty sand, slight gravel, slight dolomite fragments, wet, solvent odor	Fill, solvent saturation. HNU = 200 ppm.
	C5A-03	9.6-11.3	Weathered dolomite bedrock, staining in fractures 10 to 10.5'	Bedrock. HNU=120 to 200 ppm.

Table 2-1. Summary of Borehole Logs (Continued, Page 3 of 4)

Borehole Number	Borehole Sample Number	Depth Interval (feet)	Description	Remarks
B2A	B2A-01	0-4.5	Brown silt, sand, slight fine gravel, occasional dolomite fragment, gray sludge, black staining, red/brown oily granular sludge	Fill, sludge, staining. HNU=200 to 300 ppm. LEL reading 20%.
	B2A-02	4.5-6.0	Weathered dolomite bedrock	Bedrock. HNU = 210 ppm.
B1A	B1A-01	0-6.0	Brown silt, sand, occasional fine gravel, black staining, piece of black rubber	Fill, staining. HNU = 1 to 180 ppm.
	B1A-02	6-9.5	Soft, wet, gray sludge with slight sand	Sludge. HNU = 300 ppm.
	B1A-03	9.5-12.0	Weathered dolomite bedrock	Bedrock. HNU = 150 ppm.
C3A	C3A-01	0-2.0	Brown silt, sand, slight clay, fine to medium gravel, occasional dolomite fragments	Fill. HNU at background.
	C3A-02	2-14.5	Wet gray sludge, very soft, slightly sandy, slight black, yellow, green, blue "dry" paints, sponge-like	Sludge, pigments. HNU=150 to 250 ppm.
	C3A-03	14.5-16.0	Weathered dolomite bedrock	Bedrock. HNU = 300 ppm.
C12A	C12A-01	0-2.0	Dark brown silt, sand, slightly moist, no visible contamination	Fill, no visible contamination. HNU at background.
	C12A-02	2-12.8	Brown silt and sand, solvent saturation, gray sludge, slight pink sludge, black staining	Fill, sludge, pigments. HNU = 20 to 300 ppm.
	C12A-03	12.8-14.0	Weathered dolomite bedrock	Bedrock. HNU = 300 ppm.

Table 2-1. Summary of Borehole Logs (Continued, Page 4 of 4)

Borehole Number	Borehole Sample Number	Depth Interval (feet)	Description	Remarks
C8A	C8A-01	0-2.0	Weathered dolomite bedrock, 2-inch soil, original material	HNU at background.
	C8A-02	0-2.0	Weathered dolomite bedrock, 3-inch soil, original material	HNU at background.
	C8A-03	0-2.0	Weathered dolomite bedrock, 2-inch soil, original material	HNU at background.
C6C	C6C-01	0-2.0	Weathered dolomite bedrock, 3-inch soil	Spoon in bouncing on solid material. HNU at background.
B5A	B5A-01	0-0.8	Weathered dolomite bedrock, 2-inch soil	Refusal at 0.8 feet. HNU at background.
A3A	A3A-01	0-2	Weathered dolomite bedrock, 2-inch soil	Spoon bouncing on bedrock. HNU at background.
B3A	B3A-01	0-1.8	Weathered dolomite bedrock, 4-inch soil	Refusal at 1.8 feet. HNU at background.
C9A	C9A-01	0-2.0	Weathered dolomite bedrock, 2-inch soil	HNU at background.
A9A	A9A-01	0-2.7	Very dark brown silty fine sand, loose, moist, native	Possibly native material. HNU at background.
	A9A-02	2.7-4.6	Brown silty till, stiff, fine sand, occasional fine to medium gravel, dry	Native material. HNU at background.
	A9A-03	4.6-6.0	Weathered dolomite bedrock	Bedrock. HNU at background.

Source: ESE, 1985.

Table 2-2. Report of Incineration Analyses of Soil/Sludge Samples Collected at the Acme Solvents Site, September 1985

Parameter	B4A-02	B4A-03	B4B-01	B4B-02	C4A-01	C4A-02	C6A-01	C6A-02	C6B-02	C6B-04	D7A-01	D7A-02	C5A-02	B2A-01	B1A-01	B1A-02	C3A-02	C12A-02	B3A-01	A9A-01
Volatiles (@ 104 C) % w/w	7.79	4.45	7.44	14.99	6.67	14.42	8.24	9.96	13.72	3.76	15.93	14.81	11.78	19.38	10.36	26.19	41.16	15.01	7.50	15.93
Ash, non-vol @ 1000 C % w/w	82.83	75.09	74.42	70.00	84.37	77.54	78.33	61.56	75.22	72.10	78.97	71.03	67.53	55.32	76.63	51.72	21.22	81.44	56.98	80.14
Total chloride, % w/w	0.11	0.76	0.69	0.96	0.68	0.99	0.59	0.97	0.58	0.72	0.24	0.28	0.06	1.05	0.60	0.09	0.08	0.51	0.46	0.65
Total sulfur, % w/w	0.24	0.03	0.36	0.04	0.01	0.06	0.09	0.03	0.03	0.01	0.04	0.46	0.06	0.14	0.02	0.07	0.27	0.04	0.02	0.02
Btu Value, Btu/lb	<10	<10	94	<10	1346	587	<10	434	702	<10	337	5758	618	1311	693	2119	5573	202	<10	475
PCB, mg PCB/kg	0.43	<0.05	0.65	2.5	<0.05	7.9	0.09	1.8	2.6	<0.05	1.8	13.0	2.6	232	7.5	8.0	102	0.64	<0.05	<0.05
Type	1254*	x	1254*	1254*	x	1254*	1242	1254*	1254*	x	1254*	1254*	1254*	1254*	1254*	1254*	1254*	1254*	x	x
EP Toxicity, Test Method No.	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24	261.24
Silver, mg Ag/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic, mg As/l	0.009	0.011	0.013	<0.005	0.006	0.049	0.066	0.006	0.011	0.005	0.014	<0.005	<0.005	<0.005	<0.005	0.040	<0.005	0.005	<0.005	0.068
Barium, mg Ba/l	0.13	0.25	0.16	0.26	0.11	0.31	0.16	0.42	0.29	0.49	0.40	1.23	0.60	0.68	0.19	0.28	0.27	0.16	0.56	0.038
Cadmium, mg Cd/l	0.015	0.015	0.012	0.013	0.010	0.013	0.014	0.017	0.010	0.019	0.273	0.017	0.030	0.014	0.013	0.012	0.010	0.003	0.017	0.003
Chromium, (total) mg Cr/l	0.100	0.088	0.114	0.375	0.102	0.271	0.077	0.103	0.401	0.082	0.124	0.466	0.310	1.19	0.074	1.96	2.26	0.031	0.088	0.011
Chromium, (hex.) mg Cr/l	0.060	0.021	<0.005	0.375	0.038	0.209	0.034	0.041	0.400	<0.005	0.124	0.466	0.310	1.19	0.039	1.96	0.725	0.024	0.038	<0.005
Mercury, mg Hg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lead, mg Pb/l	<0.10	0.56	0.27	0.23	0.78	<0.10	<0.10	0.39	<0.10	0.32	<0.10	0.57	0.42	0.22	0.26	0.19	0.19	0.10	0.29	<0.10
Selenium, mg Se/l	0.009	<0.005	<0.005	0.006	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.027	0.006	0.101	0.007	0.012	0.044	<0.005	0.014	<0.005

* Calculated as Type 1254, however sample contains patterns characteristic of Aroclors 1242 thru 1260.

Source: Environmental Analysis, 1985.

Table 2-3. Analytical Results on Samples B4B-02 and C6B-02 and Their Ash

Parameter	Soil B4B-02	Ash B4B-02	Soil C6B-02	Ash C6B-02
Volatiles (@ 104 C) % w/w	14.99	NA	13.72	NA
Ash, non,vol @ 1000 C % w/w	70.00	NA	75.22	NA
Total chloride, % w/w	0.96	NA	0.58	NA
Total sulfur, % w/w	0.04	NA	0.03	NA
Btu value, Btu/lb	<10	NA	702	NA
PCB, mg PCB/kg	2.5	NA	2.6	NA
Type	1254*	NA	1254*	NA
Ep toxicity, test method no.	261.24	261.24	261.24	261.24
Silver, mg Ag/l	0.027	.01	0.011	<0.01
Arsenic, mg As/l	<0.005	<0.005	<0.005	0.011
Barium, mg Ba/l	0.87	0.26	0.69	0.29
Cadmium, mg Cd/l	0.057	0.013	0.018	0.010
Chromium, (total) mg Cr/l	0.274	0.375	0.024	0.401
Chromium, (hex.) mg Cr/l	0.255	0.375	0.024	0.401
Mercury, mg Hg/l	0.002	<0.002	0.002	<0.002
Lead, mg Pb/l	0.83	0.23	<0.10	<0.10
Selenium, mg Se/l	<0.005	0.006	<0.005	<0.005
Moisture (% wet wt)	16.3	NA	13.9	NA
Volatiles				
Acrolein, sed ug/kg-dry	<2300	NA	<1600	NA
Acrylonitrile, sed ug/kg-dry	<2300	NA	<1600	NA
Benzene, sed ug/kg-dry	2600	NA	720	NA
Bromomethane, sd ug/kg-dry	<200	NA	<150	NA
Bromodichloromethane, sd ug/kg-dry	<130	NA	<92	NA
Bromoform, sed ug/kg-dry	<310	NA	<230	NA
Carbon tetrachloride, sd ug/kg-dry	<100	NA	(72	NA
Chlorobenzene, sed ug/kg-dry	<7600	NA	<3500	NA
Chloroethane, sed ug/kg-dry	<430	NA	<310	NA
2-chl'ethylvinlether, sd ug/kg-dry	<1300	NA	<880	NA
Chloroform, sed ug/kg-dry	<180	NA	<87	NA
Chloromethane, sed ug/kg-dry	<160	NA	<110	NA
Dibromochloromethane, sd ug/kg-dry	<200	NA	<150	NA

* Calculated as Type 1254, however, sample contains patterns characteristic of Aroclors 1242 thru 1260.

Table 2-3. Analytical Results on Samples B4B-02 and C6B-02 and Their Ash
(Continued, Page 2 of 5)

Parameter	Soil B4B-02	Ash B4B-02	Soil C6B-02	Ash C6B-02
Dichl'difluo'methane, sd ug/kg-dry	1700	NA	1200	NA
1,1-dichl'ethane, sed ug/kg-dry	<110	NA	<81	NA
1,2-dichloroethane, sd ug/kg-dry	<110	NA	<81	NA
1,1-dichl'ehtene, sed ug/kg-dry	850	NA	<150	NA
T-1,2-dichloroethene, sd ug/kg-dry	<180	NA	<140	NA
1,2-dichloropropane, sd ug/kg-dry	<200	NA	<290	NA
CIS-1,3-dich'propene, sd ug/kg-dry	<610	NA	<440	NA
T-1,2-dich'propene, sd ug/kg-dry	<670	NA	490	NA
Ethylbenzene, sed ug/kg-dry	810000	NA	410000	NA
Methylene chlor., sed ug/kg-dry	15000	NA	810	NA
1,1,2,2-Tet'ch'ethan, sd ug/kg-dry	<1700	NA	<930	NA
Tet'chl'ethylene, sed ug/kg-dry	17000	NA	12000	NA
1,1,1-trichl'ethane, sd ug/kg-dry	12000	NA	2700	NA
1,1,2-trichl'ethane, sd ug/kg-dry	<180	NA	<160	NA
Trichloroethene, sed ug/kg-dry	29000	NA	11000	NA
Trichlorofluorometh, sd ug/kg-dry	<230	NA	<160	NA
Toluene, sed ug/kg-dry	570000	NA	670000	NA
Vinyl chloride, sed ug/kg-dry	<170	NA	<120	NA
Base/Neutrals				
Acenaphthene, sed ug/kg-dry	110	<3	880	<3
Acenaphthylene, sed ug/kg-dry	<10	<2	<20	<2
Anthracene, sed ug/kg-dry	<16	<3	47	<3
Benzo(A)anthracene, sd ug/kg-dry	<58	<10	<120	<9
Benzo(B)fluoran., sed ug/kg-dry	<150	<26	<310	<25

Table 2-3. Analytical Results on Samples B4B-02 and C6B-02 and Their Ash (Continued, Page 3 of 5)

Parameter	Soil B4B-02	Ash B4B-02	Soil C6B-02	Ash C6B-02
Base Neutrals (Continued)				
Benzo(K)fluoran, sed ug/kg-dry	<120	<21	<250	<20
Benzo(A)pyrene, sed ug/kg-dry	<180	<30	<360	<29
Benzo(GHI)perylene, sd ug/kg-dry	<960	<160	<1900	<150
Benzioine, sed ug/kg-dry	<250	<43	<510	<41
Bis(2-chlethyl)ether, sd ug/kg-dry	<19	<3	<39	<3
Bis(2-chlethox)mthan, sd ug/kg-dry	<18	<3	<37	<3
Bis(2-chlisopr)ether, sd ug/kg-dry	<39	<7	<78	<6
Bis(2-ethylhex)phth, sd ug/kg-dry	85000	33	280000	67
4-brphnl phnl ether, sd ug/kg-dry	<91	<15	<180	<15
Butyl ben.phthalate, sd ug/kg-dry	5000	<14	16000	<13
2-chlnaphthalene, sed ug/kg-dry	<17	<3	<34	<3
4-chlphylphenylehter sd ug/kg-dry	<44	<7	<88	<7
Chrysene, sed ug/kg-dry	<63	<11	<130	<10
Dibenzo(A,H)anthra, sd ug/kg-dry	<720	<120	<1400	<120
Di-n-butyl phthalate, sd ug/kg-dry	20000	<3	74000	20
1,3-dichlbenzene, sed ug/kg-dry	<26	<4	<52	<4
1,4-dichlbenzene, sed ug/kg-dry	<23	<4	<47	<4
1,2-dichlbenzene, sed ug/kg-dry	<26	<4	<52	<4
3,3-dichlbenzene, sed ug/kg-dry	<260	<44	<520	<42
Diethyl phthalate, sd ug/kg-dry	200	<3	170	<3
Dimethyl phthalate, sd ug/kg-dry	830	<2	14000	<2
2,4-dnt, sed ug/kg-dry	<55	<9	<110	<9
2,6-dnt, sed ug/kg-dry	<71	<12	<140	<12
Di-n-octyl phthalate, sd ug/kg-dry	730	51	1400	200
1,2-diph'hydraz., sed ug/kg-dry	<13	<2	<26	<2
Fluoranthene, sed ug/kg-dry	<27	<5	110	<4
Fluorene, sed ug/kg-dry	69	<3	470	<3
Hexaclrbenzene, sed ug/kg-dry	<75	<13	<150	<12
Hexachlbutadiene, sed ug/kg-dry	<73	<12	<140	<11
Hexachl'ethane, sed ug/kg-dry	<68	<12	<140	<11

Table 2-3. Analytical Results on Samples B4B-02 and C6B-02 and Their Ash (Continued, Page 4 of 5)

Parameter	Soil B4B-02	Ash B4B-02	Soil C6B-02	Ash C6B-02
Base Neutrals (Continued)				
Hexach'cyc'pen'diene, sed ug/kg-dry	<110	<19	<220	<18
Indeno(1,2,3-cd)pyr, sd ug/kg-dry	<650	<110	<1300	<110
Isophorone, sed ug/kg-dry	22000	<3	170000	<3
Naphthalene, sed ug/kg-dry	31800	<2	227000	<1
Nitrobenzene, sed ug/kg-dry	<29	<5	<58	<5
N-nitrosodimet'amine, sd ug/kg-dry	<37	<6	<74	<6
N-nitrosodipro'amine, sd ug/kg-dry	<36	<6	<72	<6
N-nitrosodiphe'amine, sd ug/kg-dry	<27	<5	<55	<4
Phenanthrene, sed ug/kg-dry	55	<3	320	<2
Pyrene, sed ug/kg-dry	<27	<5	110	<4
2,3,7,8-TCDD, sed ug/kg-dry	<48	<8	<96	<8
Acids				
1,2,4-trichl'benzene, sd ug/kg-dry	<35	<5	<71	<6
P-chlor-m-cresol, sed ug/kg-dry	<37	<6	<75	<6
2-chlorophenol, sed ug/kg-dry	<27	<5	<53	<4
2,4-dichl'phenol, sed ug/kg-dry	<37	<6	<75	<6
2,4-dimet'phenol, sed ug/kg-dry	<33	<6	<67	<5
2,4-dinit'phenol, sed ug/kg-dry	<330	<57	<670	<54
4,6-dinit'-o-cresol sd ug/kg-dry	<170	<29	<350	<28
2-nitrophenol, sed ug/kg-dry	<60	<10	<120	<10
4-nitrophenol, sed ug/kg-dry	<140	<24	<290	<23
Pentachlphenol, sed ug/kg-dry	<170	<28	1200	<27
Phenol, sed ug/kg-dry	880	<3	12000	<3
2,4,6-trichlphnl, sed ug/kg-dry	<56	<10	<110	<9
Pesticides & PCBs				
Aldrin, sed ug/kg-dry	<130	<0.1	<130	<0.1
BHC,A, sed ug/kg-dry	<0.8	<0.07	<0.8	<0.07
BHC,B, sed ug/kg-dry	<18	<0.1	<17	<0.1
BHC,D, sed ug/kg-dry	<21	<0.2	<20	<0.2
BHC,G(lindane), sed ug/kg-dry	130	<0.1	140	<0.1
Chlordane, sed ug/kg-dry	63	<1.9	64	<1.9
DDD,PP', sed ug/kg-dry	<12	<1.0	<12	<1.0
DDE,PP' sed ug/kg-dry	<250	<0.2	<240	<0.2
DDT,PP' sed ug/kg-dry	<930	<0.8	<910	<0.8

Table 2-3. Analytical Results on Samples B4B-02 and C6B-02 and Their Ash (Continued, Page 5 of 5)

Parameter	Soil B4B-02	Ash B4B-02	Soil C6B-02	Ash C6B-02
Dieldrin, sed ug/kg-dry	<31	<0.3	<30	<0.3
Endosulfan,A, sed ug/kg-dry	<25	<0.2	<24	<0.2
Endosulfan,B, sed ug/kg-dry	<53	<0.4	<52	<0.4
Endosulfan sulf., sed ug/kg-dry	<250	<2.1	<240	<2.1
Endrin, sed ug/kg-dry	<83	<0.7	<81	<0.7
Endrin ald., sed ug/kg-dry	<75	<0.6	<73	<0.6
Heptachlor, sed ug/kg-dry	<110	<0.09	<110	<0.09
Heptachlor epox., sed ug/kg-dry	<18	<0.2	<18	<0.2
Toxaphene, sed ug/kg-dry	<290	<24	<280	<24
PCB-1016, ug/kg-dry	1500	<3	1500	<3
PCB-1260, ug/kg-dry	3600	<4	2900	<4

Sources: ESE, Inc. 1985 For organic priority pollutants.
EA, Inc. 1985 For EP Toxic Metals, Total PCBs and incinerator parameters.

3.0 DETERMINATION OF ELEVATED CONTAMINATION ZONES AND INCINERATION OPTIONS

In this section, data and other information presented in previous sections of this report are utilized to develop volumes of contaminated materials and to determine the feasibility, costs, and relative merits of offsite and onsite incineration of the elevated contaminated materials at the ACME Solvents site.

3.1 VOLUME OF CONTAMINATED MATERIALS

3.1.1 Soil

An estimate of excavation volumes for soil has been developed using conservative surface areas and depths to bedrock at individual mounds. The site was divided into eight mound areas (Figure 3-1). The surface area within each contour was determined by planimeter. The depths to bedrock were assumed for each mound based on the bedrock contours derived from the borehole data and previous test pit data.

In order to calculate the estimated volumes, each mound was divided horizontally into sections 2 feet deep. This interval depth corresponds to the topographic contour intervals on Figure 3-1. The area of each section was determined by planimeter. Volumes for each section were calculated based on section area and the 2 foot depth. The depth of the bottom section of each mound was assumed to be the average depth to bedrock. Summing the resulting volumes provided the volume per mound to be excavated. A summary of results is provided in Table 3-1.

To determine the excavation volume for the contaminated bedrock materials, the surface area was again determined by planimeter. This value represents the volume of material per foot of excavation.

3.1.2 Elevated Contamination Zone

The elevated contamination zones are defined as those portions of the mounds which contain sludge or other visible contamination such as

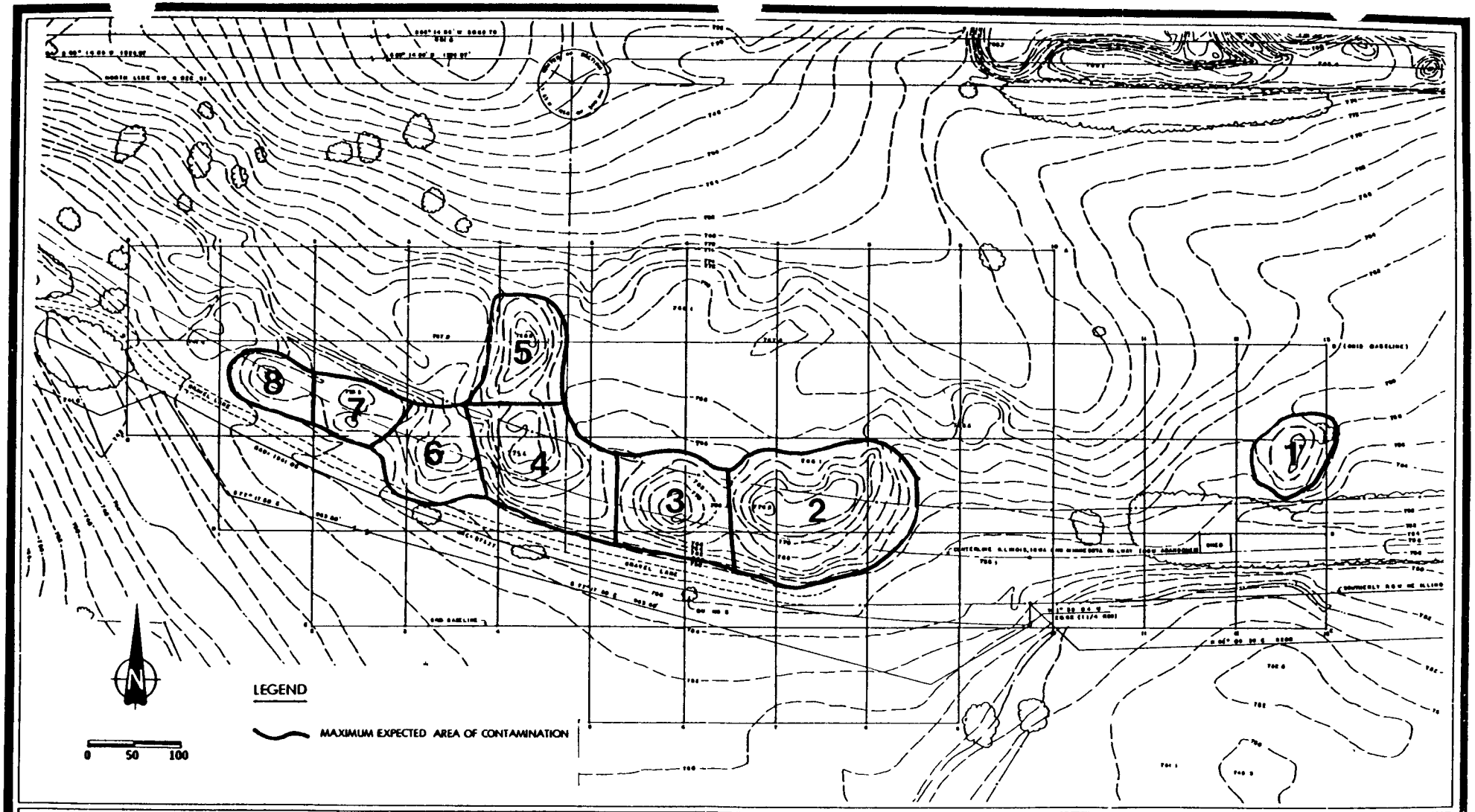

Figure 3-1
WASTE AREAS FOR VOLUME DETERMINATION
ACME SOLVENTS

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Table 3-1. Estimated Waste Volumes

Mound	Estimated Soil Volume (yd^3)	Elevated Contamination Zone Volume (yd^3)	Comments
1	2,116	740	
2	14,277	4,013	P.P. Analysis*
3	4,888	1,529	
4	6,655	129	P.P. Analysis*
5	2,307	2,622	
6	3,002	2,372	PCB>50ppm
7	1,272	725	PCB>50ppm
8	1,080	343	
Total Mounds:	35,596	12,473	

Bedrock: 3,416 yd^3 per foot of excavation

* P.P. = Priority Pollutant

Source: ESE, 1985.

staining within the fill material. In order to determine volumes, the bore logs and test pit data were reviewed to approximate the location of elevated contamination zones within each mound. Cross sections depicting the elevated contamination zones and the locations are found in Figures 3-2 and 3-3.

To estimate elevated contamination zone volumes, the bore log data was used to determine which sections of each mound would contain elevated contamination. Using the planimeter and the cross sections, the percent of elevated contaminated material within the affected sections was estimated. The results of this exercise are summarized in Table 3-1. The total volume of elevated contmainated material is estimated at 12,473 cubic yards.

3.1.3 Drums

Actual number of buried drums at the site is not known. Field conditions suggest the existence of 1,000 to 4,000 drums at the site. It is not known how many of the drums may contain materials. For purposes of comparative cost estimating, 2,000 will be used as the number of drums to be handled. This is the equivalent of 666 cubic yards.

3.2 OFFSITE INCINERATION

Due to the high costs of transporting contaminated materials over a long distance, the search for existing offsite commercial incinerators was limited to a 500-mile radius of the site. State regulatory agencies were contacted to locate those commercial incinerators within the 500-mile radius that are RCRA-approved to handle PCB-contaminated soils and sludges (see Appendix C). The commercial incinerators so identified were contacted directly to verify that they are RCRA-approved and would accept PCB-contaminated wastes. This selective search yielded two commercial facilities: ENSCO, Inc. of El Dorado, Arkansas, and SCA Chemical Services, Inc. of Chicago, Illinois (Table 3-2).

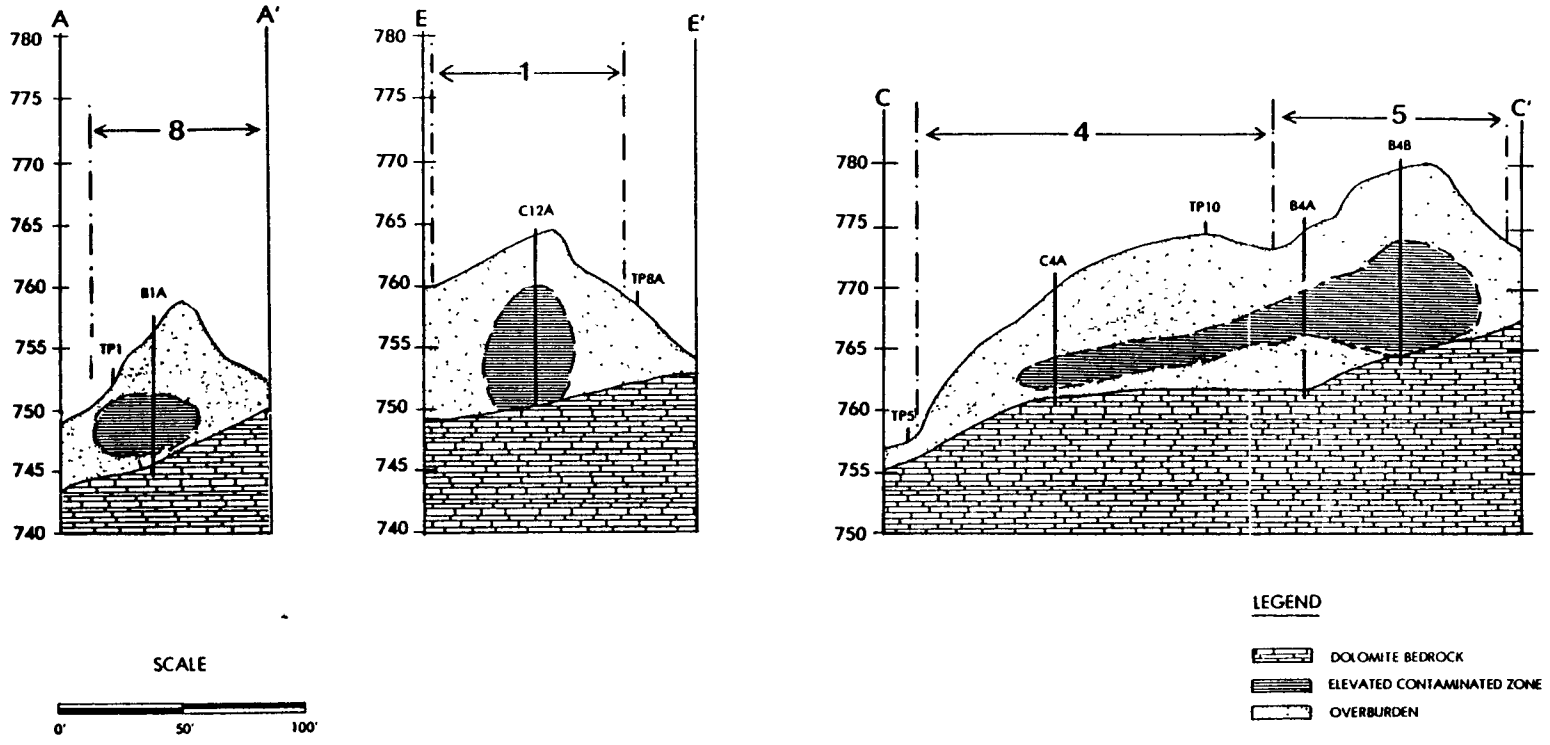

Figure 3-2
WASTE MOUND CROSS SECTIONS A-A', E-E', C-C'
PAGE1 OF 2

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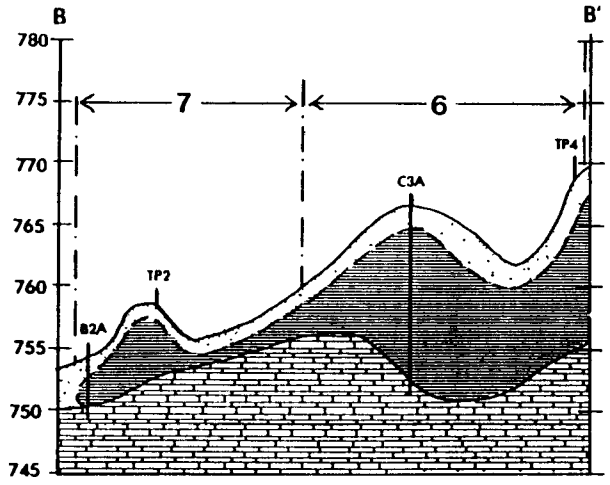

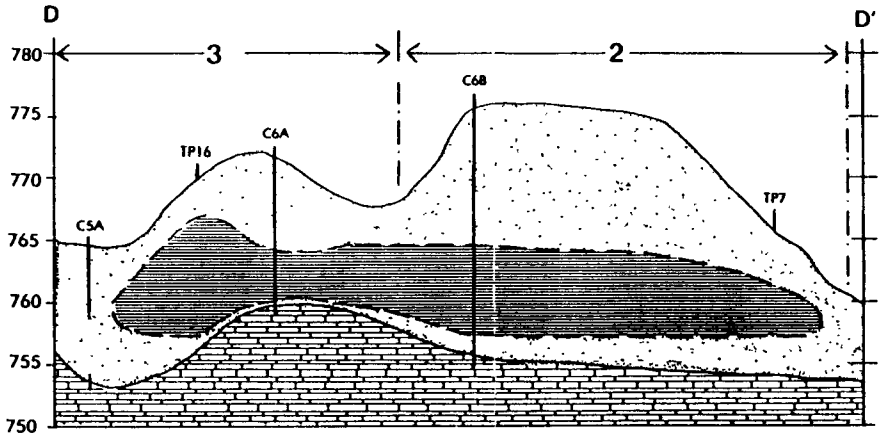

SCALE

0' 50' 100'

LEGEND

DOLOMITE BEDROCK

ELEVATED CONTAMINATED ZONE

OVERBURDEN

Figure 3-2
WASTE MOUND CROSS SECTIONS B-B' D-D'
PAGE 2 OF 2

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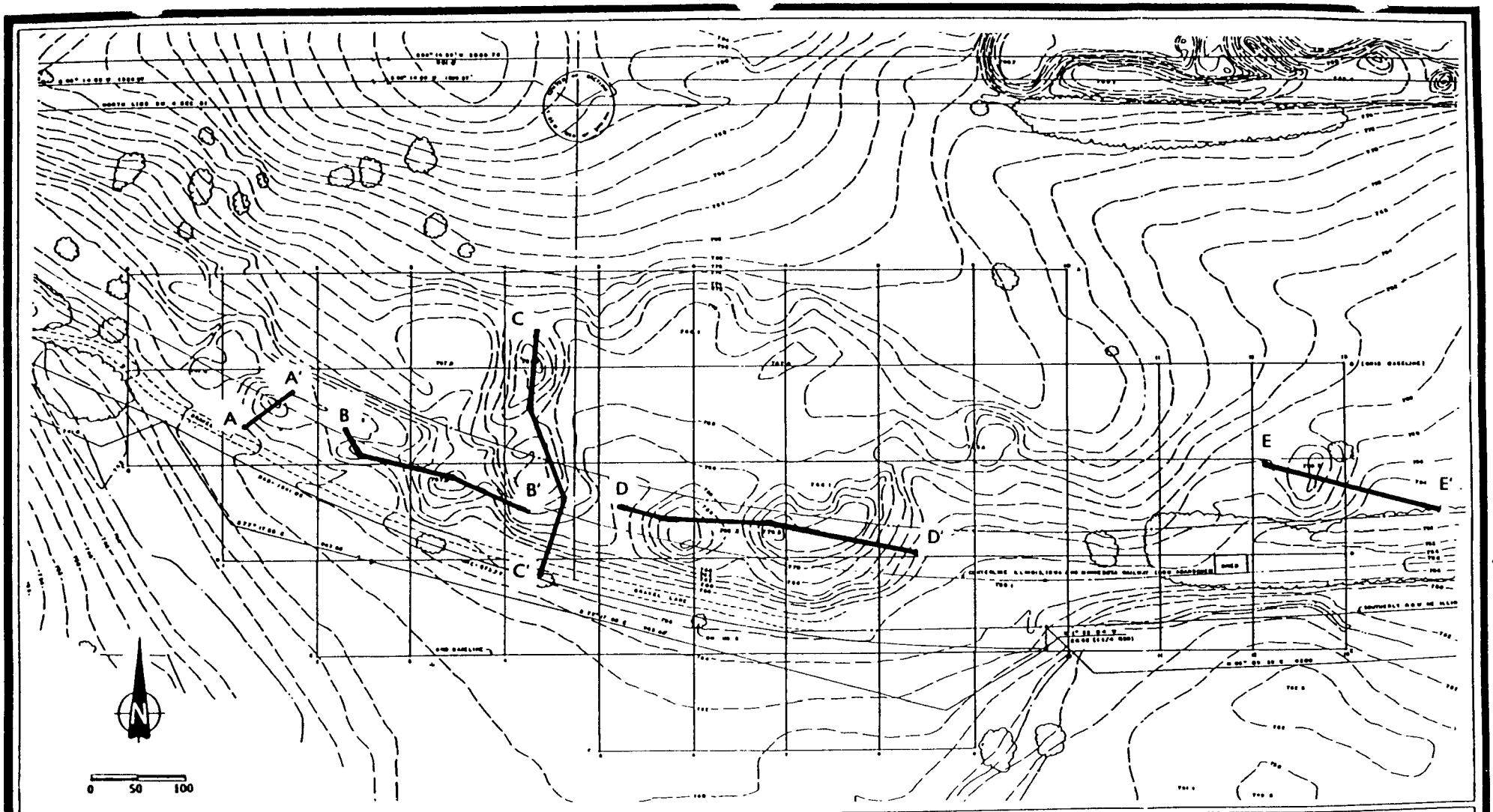

Figure 3-3
WASTE MOUND CROSS-SECTIONAL TRANSECTS
ACME SOLVENTS SITE

ENVIRONMENTAL SCIENCE
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Table 3-2. Summary of Offsite Commercial Facilities Incinerating PCB-Contaminated Wastes

Facilities	ENSCO, Inc.	SCA Chemical Services, Inc.
Address/Phone/ Location	1015 Louisiana St. Little Rock, Arkansas 72202 (501) 375-8444	11700 S. Stony Island Ave. Chicago, Illinois 60617 (312) 646-5700
Contact	Mr. Gary Martini	Ms. Sharon Pilachowski
EPA ID#	ARD069748192	LID060672121
Years of Operation	4	3
Form of Acceptable Wastes	Bulk and Drummed Liquids and Solids	Bulk Liquids and Drummed Solids
Incinerator Type	Rotary Kiln	Rotary Kiln
Method of Ash Disposal	RCRA-Permitted Landfill	RCRA-Permitted Landfill
Date of Availability	January 1986	January 1986
Cost of Incineration	$28.9 million	$32.4 million
Time to Implement	2-3 years	2 years
Storage Capacity	None	None

Source: ESE, 1985.

3.2.1 ENSCO, Inc.

ENSCO has been incinerating PCB-contaminated wastes since 1981. A brief summary of this facility is presented in Table 3-2. They employ a rotary kiln incineration system with a thermal oxidation chamber and afterburner with a cyclone. The facility will accept solid waste materials either in bulk or in drums. Ash generated by the incinerator is routinely disposed of by the facility in RCRA-permited landfills. They will not accept heavy sludges that do not pass a 60 mesh screen. They will also reject raw sulfur and wastes contaminated with any amount of dioxin. Discussions with Mr. Gary Martini indicate ENSCO's facility would accept waste materials from the ACME Solvents site, based on existing analytical data for these waste materials. Chloride, sulfur, and PCB concentrations would not prohibit ENSCO's acceptance of the waste materials. The facility would be available to accept waste materials from the ACME Solvents site in January 1986. Current costs of incineration at ENSCO Inc.'s facility are on the order of $0.75-1.00/lb for bulk solids and $1.00 per pound for drummed solids. These costs include ash disposal. Specific costs can be provided only after analysis of the waste materials by ENSCO, Inc.'s laboratory. Based on a projected volume of 12,473 cubic yards and 2,000 drums or 28,905,800 pounds of contaminated materials at the site, incineration costs would be approximately $28.9 million. Current projections of capacity at ENSCO, Inc. indicate incineration of this volume would require 2 to 3 years.

ENSCO, Inc. also provides transportation services at a unit cost of $3.25 per loaded mile. Based on the expected volume, total transportation costs would be about $1.3 million.

3.2.2 SCA Chemical Services, Inc.

SCA Chemical Services, Inc. has been incinerating PCB-contaminated wastes for 2 years and other waste types for 3 years. A brief summary

of this facility is presented in Table 3-2. They employ a rotary kiln incineration system with a secondary kiln. The facility will accept liquid and drummed solid waste materials. All solid waste must be drummed in burnable containers prior to being transported to the incinerator. This requirement results in additional packaging and loading costs not required by ENSCO. Ash generated by the incineration process is routinely disposed of in a RCRA-permitted landfill. Discussions with Ms. Sharon Pilachowski indicate SCA's facility would accept waste materials from the ACME Solvents site, based on existing analytical data of these waste materials. Chloride, sulfur, and PCB concentrations would not prohibit SCA's acceptance of the waste materials.

The facility would be available to accept waste materials from the ACME Solvents site beginning January 1986. Current cost of incineration at SCA's facility are on the order of $1.12 per pound. These costs include ash disposal. Specific costs can be provided only after analysis of the waste materials by SCA's laboratory. Based on a projected volume of contaminated materials at the site, incineration costs would be about $32.37 million. Current projections of capacity at SCA's facility indicate incineration of this volume would require 2 years.

SCA also provides transportation services using their own vehicles or exclusive subcontractors. The charge for this service is $3.41 per loaded mile. The total transportation charge for hauling waste from the ACME Solvents site to the SCA incinerator would be approximately $0.31 million.

3.2.3 Feasibility of Offsite Incineration

As previously discussed, two commercial facilities were located, that would accept the contaminated waste materials from the ACME Solvents site. These facilities are ENSCO, Inc. in El Dorado, Arkansas and SCA

Chemical Services, Inc. in Chicago, Illinois. Both facilities would be available to accept contaminated waste materials from the site beginning January 1986. Incineration of these wastes by each facility would take approximately 2 to 3 years, assuming a constant incineration rate of the 13,139 cubic yards over a 3 year period results in a projected daily incineration rate of approximately 12 cubic yards per day. This equates to approximately one truckload of the contaminated materials per day, assuming a 16 cubic yard capacity truck. Because neither commerical facility has storage capacity for these materials, excavation and removal of the contaminated materials from the site must proceed at the same rate (16 cubic yards per day) or be stockpiled onsite if a faster excavation rate is maintained.

3.3 ONSITE INCINERATION

Several vendors with mobile incineration capabilities were contacted. Vendors who responded included ENSCO, Inc., Waste Tech Services, Inc. ThermAll, Inc., Canavan Technologies, Inc., Shirco Infrared Systems, Inc., CECOS Environmental; and Haztech. With the exception of ENSCO, Inc., the vendors could not provide a complete onsite mobile incinerator system within a reasonable time period for one or more of the following reasons:

1. The incinerators were still in the design phase, (reliability of their incineration systems has not been determined);
2. Costing information could not be provided without a site visit;
3. An incineration system could be purchased but operating personnel would not be provided; and
4. Date of availability was unknown.

Thus, it appears that ENSCO, Inc. alone could provide the most cost-effective and efficient mobile incineration system. Therefore only information provided by ENSCO was used to determine the feasibility of onsite incineration. It should be noted that several vendors may be able to provide an acceptable system in the future and could be considered during actual mobile incinerator selection.

3.3.1 ENSCO, Inc.

ENSCO, Inc. has been providing incineration services involving PCB destruction since 1981. Currently ENSCO has two mobile rotary kiln incinerators capable of incinerating solids, liquids, and sludges. These incinerators are currently in operation onsite at two locations in the United States. These incinerators can be equipped with shredders to handle drums buried onsite. Both incinerators are available for lease as of the first quarter of 1986, provided that ENSCO is contacted by October 1, 1985. According to ENSCO personnel, a third rotary kiln mobile incineration unit, currently being manufactured, of equal capability to the existing units should be available during the same time period. Two additional incinerators that could handle only liquid wastes should also be available for the first quarter of 1986.

ENSCO would provide normal routine permitting assistance to its client. The permitting fee is included in the base cost to incinerate the material. The time required to obtain the permits would be determined by the State of Illinois Environmental Protection Agency, generally ranging from 6 months to 2 years.

ENSCO's costs to incinerate contaminated wastes are based on the weight or volume of material to be incinerated. This base cost estimate includes assistance in permitting, mobilization, demobilization, set-up of incinerator, operating, personnel, incineration of contaminated wastes, and environmental emissions control. The base cost would be about $800 per cubic yard of material to be incinerated. ENSCO could provide a more accurate cost estimate after a site visit to determine specific site conditions. The total volume of contaminated waste to be removed is approximately 12,473 cubic yards and 2,000 drums, which translates to a cost of $10.51 million for onsite incineration.

The maximum capacity of ENSCO's rotary kiln incinerator is approximately 100 cubic yards per day. The estimated incineration time, after permits

have been secured and the incinerator is onsite, is approximately 9 months. The estimated incineration time is based upon a 25 percent downtime for the incinerator and the characteristics of the wastes to be incinerated.

3.3.2 Feasibility of Onsite Incineration

As discussed in Section 3.3.1 ENSCO could provide complete onsite incineration services. ENSCO would be available the first quarter of 1986. Their rotary kiln incinerator can handle solids, liquids, and sludges. Concentration of PCB's, chlorides, and sulfur in the contaminated wastes would not prohibit the implementation of onsite incinerator. The estimated incineration time would be approximately 9 months. Assuming a constant incineration rate of the waste over a 9-month period results in a projected daily average incineration rate of 80 to 100 cubic yards per day. A track mounted backhoe could be used to excavate 100 to 200 cubic yards of contamination wastes per day so that extensive stock piling would not be required.

Uncertainties regarding availability, permitting, test burn results, local opposition, operation and delisting of the ash/decontaminated soil exist for onsite incineration. These uncertainties may impact the cost and schedule and potentially even the implementation of onsite incineration.

3.4 OFFSITE VERSUS ONSITE INCINERATION

Summarizations of offsite and onsite incineration capabilities and costs are presented in Tables 3-3 and 3-4. The time required to obtain necessary state and federal permits in addition to the availability of units may delay implementation of onsite incineration as much as 2 years. Thus, completion of incineration would take approximately 3 years.

The primary purpose of the cost estimates provided in this report is to allow a comparison of alternatives. These estimates do not represent the actual expected costs. In order to provide actual cost estimates additional data is required including a complete waste characterization, refined volume estimates and preliminary concept designs of the remedial actions.

The unit costs presented have been obtained from vendors where possible. Time and data limitations and unreturned calls limited detailed discussions with commercial vendors. Most vendors were hesitant to provide unit costs and generally qualified the numbers as gross estimates. Another problem which arose was apparently due to IEPA's solicitation for cost estimates from the same vendors. ENSCO, Inc. increased their cost estimates after they were contacted by the Agency.

As an example, for onsite incineration contacts with vendors yielded cost estimates ranging from $300 to $1,300 per cubic yard.

3.5 ASH/DECONTAMINATED SOIL DISPOSAL

As discussed previously in Section 2.0, waste samples were subjected to incineration conditions in the laboratory. The resulting ash/decontaminated soil was tested for EP toxicity and consistently proved to be well below EPA limits for hazardous waste classification. Assuming the ash/decontaminated soil can be delisted as a hazardous waste based on EP toxicity results, the ash/decontaminated soil can be used for backfill and regrading purposes onsite. Use of the ash as backfill will result in cost reduction for ash disposal.

3.6 ALTERNATIVE TECHNOLOGIES

Based upon the above estimated costs and uncertainties, other treatment and/or disposal technologies should be investigated for the elevated contaminated materials at the ACME Solvents site.

These technologies could include:

- solidification;
- encapsulation;
- soil flushing;
- microbiological degradation; and
- offsite landfill.

Table 3-3. Summary of Offsite and Onsite Incineration Capabilities

	Offsite Incinerator	Onsite Incinerator
Availability	January 1986	January - April 1986
Incineration Rate	25 cubic yards per day	80 to 100 cubic yards per day (maximum)
Implementation Time	2 to 3 years	2 to 3 years
Cost	$28.91 to 32.37 million	$10.51 million

Source: ESE, 1985.

Table 3-4. Summary of Offsite and Onsite Incineration Costs

	Offsite Incineration ($MM)	Onsite Incineration ($MM)
Site Preparation Mobilization	0.04	0.04
Excavation	0.37	0.37
Packaging and Loading	0.23	--
Transportation (Onsite)	--	0.07
Transportation (Offsite)	0.31	0.36*
Incineration	32.37	10.51
Ash Disposal	--	0.83†
Site Reclamation	0.02	0.02
	$33.34	$12.20

* Ash transport to offsite landfill.
† Offsite disposal in RCRA landfill.

Source: ESE, 1985.

EPA/540/2-89/031

SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

Vesta Technology, Ltd. "Trial Burn Test Report, Part I - Data Summaries." Draft report of approximately 25 pp. Prepared for U.S. EPA, Region IV, March 1987.

EPA LIBRARY NUMBER:

Superfund Treatability Clearinghouse - EZUY

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Thermal Treatment - Rotary Kiln
Media:	Soil/Generic
Document Reference:	Vesta Technology, Ltd. "Trial Burn Test Report, Part I - Data Summaries." Draft report of approximately 25 pp. Prepared for U.S. EPA, Region IV, March 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Ned Jessup U.S. EPA - Region IV 345 Courtland Street, NE. Atlanta, GA 30365 404-347-4727
Site Name:	Aberdeen, NC, Superfund Site (NPL)
Location of Test:	Aberdeen, NC

BACKGROUND: This treatability study summary reports on the results of a trial burn of pesticide-contaminated soil from the Aberdeen, NC Superfund site. The trial burn using the Vesta mobile rotary kiln incinerator was designed to demonstrate that this system can destroy the pesticides in a manner consistent with RCRA standards.

OPERATIONAL INFORMATION: The soil was fed to the incinerator at rates of 960 to 1023 pounds per hour. There were three trial runs completed, each for approximately 3 hours. No details are provided on the soil matrix or QA/QC accomplished. Since this Trial Burn Test Report is a summary of analytical results, additional operational information is not presented.

PERFORMANCE: The primary standards of performance were:

1. Destruction of the pesticides from the soil fed to the incinerator.
2. Destruction/removal of the designated principal organic hazardous pollutants (POHC's).
3. Particulate stack emissions.
4. Hydrogen chloride stack emissions.

Secondary standards included:

1. Other pesticide stack emissions.
2. Carbon monoxide emissions.
3. Dioxin, furan and other chlorinated organic emissions.

The soil treated had initial concentrations of P,P-DDT and alpha-BHC of greater than 131 and 29 ppm, respectively. The pesticides in the soil fed to the incinerator were effectively removed, as evidenced by the removal of the principal organic hazardous pollutants, P, P-DDT and alpha-BHC (99.993% and 99.998% removal efficiency, respectively). All other pesticides found in the contaminated soil were not detected in the treated soil. TCDD (dioxins) and TCDF (furans) were not found in the treated soil. The destruction and removal efficiency, of 99.993 percent particulate stack emissions to .02 grains/dscf and hydrogen chloride stack emissions of 99.2

percent removal were in compliance with RCRA criteria for particulate stack emissions of .08 grains/dscf and hydrogen chloride stack emissions removal of 99 percent. Carbon monoxide stack emissions and combustion efficiency were indicative of good combustion, except for one test run which experienced startup difficulties. Other stack emission parameters (flow, temperature, moisture, oxygen, and carbon dioxide) indicated successful operation. Quality control field blanks were collected and described.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	72-55-9	1,1-Dichloro-2-2-bis (4-chlorophenyl)ethene (4,4-DDE
	72-54-8	1,1-Dichloro-2,2-bis (4-chlorophenyl)ethane (4,4-DDD)
	50-29-3	1,1,1-Trichloro-2,2-bis (4-chlorophenyl)ethane (4,4-DDT)
W05-Halogenated Cyclic Aliphatics/Ethers/ Esters/Ketones	1024-57-3	Heptachlor Epoxide
	1031-07-8	Endosulfan Sulfate
	309-00-2	Aldrin
	319-85-7	Beta-BHC
	33213-65-9	Endosulfan II
	58-89-9	Gamma-BHC
	60-57-1	Dieldrin
	72-20-8	Endrin
	7421-93-4	Endrin Aldehyde
	76-44-8	Heptachlor
	959-98-8	Endosulfan I
	319-86-8	Delta-BHC

Received 3/4/87 from
Ned Jessup Region IV via U.S

980-TSI-RT-EZUY

Vesta Technology, Ltd.

2501 E. Commercial Blvd. • Suite 209 • Ft. Lauderdale, FL 33308 • (305) 776-0330

March 2, 1987

FEDERAL EXPRESS

United States Environmental
Protection Agency, Region IV
Emergency Response and Control Section
345 Courtland Street N.E.
Atlanta, Georgia 30365

Attn: Mr. N.E. Jessup

Dear Ned:

Enclosed please find the preliminary draft issue of the results from Aberdeen, which were delivered to us today.

The full manual with back-up figures etc. will be sent to you as soon as received.

Very truly yours,

Vesta Technology, Ltd.

Patrick A. Phillips,
Executive Vice President

PAP:eh

enclosure

RECON SYSTEMS INC.
ROUTE 202N, P.O. BOX 460, THREE BRIDGES, N.J. 08887
201-782-5900
NEW ENGLAND 617-752-4217 PENNSYLVANIA 215-433-5511

TRIAL BURN TEST REPORT

PART I - DATA SUMMARIES

for

VESTA TECHNOLOGY
6920 N. W. 44th Court
Lauderhill, Florida 33319

Source Tested:

Mobile Incinerator
at
Aberdeen, North Carolina site

In Fulfillment of Verbal Purchase Order

RECON Project No. 2473

February 28, 1987

RECON SYSTEMS, INC.

Route 202 North, P.O. Box 460
Three Bridges, N.J. 08887
201-782-5900

New England 617-752-4217 Pennsylvania 215-433-5511

Part I
Trial Burn Test Report
for
VESTA TECHNOLOGY
Incinerator Test
at
Aberdeen, North Carolina

INTRODUCTION

A trial burn in the Vesta mobile rotary kiln incinerator was conducted on December 10, and 11, 1986, at the Aberdeen, North Carolina superfund site, which has soil contaminated with pesticides. The purpose of the trial burn was to demonstrate that this incinerator system can destroy the pesticides in a manner consistent with Federal hazardous waste (RCRA) standards.

The trial burn plan was issued July 14, 1986. This report contains data obtained by RECON SYSTEMS, INC. The original field and laboratory data, calculations, calibration data, and quality assurance/quality control package are included in a separately issued document (PART II).

The primary standards of performance are:

1. Disappearance of the pesticides from the soil fed to the incinerator.

2. Destruction/removal of the designated principal organic hazardous pollutants (POHC's).

3. Particulate stack emissions.

4. Hydrogen chloride stack emissions.

Secondary standards include:

1. Other pesticide stack emissions.
2. Carbon monoxide emissions.
3. Dioxin, furan and other chlorinated organic emissions.

Data on these parameters are reported in the summary and body of the report.

Other stack gas and soil parameters were also measured and are reported.

Exceptions/modifications to the trial burn plan are noted.

The report contains the following sections:

SUMMARY

The results of the trial burn indicate the incinerator removed the pesticides form the soil and met the required Federal hazardous waste (RCRA) standards.

The pesticides in the soil fed to the incinerator were effectively removed, as evidenced by disappearance of the POHC's (a-BHC and P,P'-DDT):

Test No.	1	2	3
Residual a-BHC, ppb (dry)	1.8	ND 2.5	ND 0.5
Removal of a-BHC, %	99.9991	≥ 99.9988	≥ 99.9996
Residual P,P'-DDT, ppb (dry)	ND 2.0	ND 2.0	ND 2.0
Removal of P,P'-DDT, %	≥ 99.9985	≥ 99.9990	≥ 99.9933

All other pesticides found in the contaminated soil were not detected in the treated soil. TCDD (dioxins) and TCDF (furans) were not found in the treated soil.

The destruction and removal efficiency (DRE) was found to be in compliance with the RCRA standard of 99.99%:

a-BHC DRE, %	99.9950	≥ 99.9988	99.9995
P,P'-DDT DRE, %	≥ 99.9995	≥ 99.9993	≥ 99.9931

The particulate stack emissions were found to be in compliance with the RCRA standard of 0.08 grains/dscf corrected to 7% oxygen:

Particulate Grains/dscf corrected to 7% O_2	0.0226	0.0136	0.0180

The hydrogen chloride stack emissions were found to be in compliance with the RCRA standards of 4 pounds/hour and 99% removal:

HCl, Pounds/hour	0.00426	0.00815	0.00511
Removal of HCl entering scrubber, %	99.71	99.22	99.82

The carbon monoxide stack emissions and combustion efficiency (CE) were found to be indicative of good combustion (except for Test No. 1, where startup difficulties were experienced and poor results expected):

Carbon Monoxide, ppmv (dry)	6250	1	1
Combustion Efficiency (CE), %	93.506	99.999	99.999

Other stack emission parameters indicated successful operation:

Flow, scfm	1710	1910	1880
Temperature, ^{o}F	155	148	149
Moisture, %	26.9	23.3	24.8
Oxygen, %	8.0	10.0	10.8
Carbon Dioxide, %	9.0	7.2	7.0

EMISSIONS

Particulates, Pounds/hour	0.226	0.135	0.159
Particulates, grains/dscf	0.0210	0.0107	0.0131
Carbon Monoxide, Pounds/hour	34.2	0.006	0.006
Carbon Monoxide, ppmv	4570	0.77	0.75
Hydrogen Chloride, Pounds/hour	0.00426	0.00815	0.00511
Hydrogen Chloride, ppmv	0.44	0.75	4.79
a-BHC (POHC), Pounds/hour	8.21 (10^{-6})	ND	0.557 (10^{-6})
P,P'-DDT (POHC), Pounds/hour	ND	ND	ND
Other Pesticides, Pounds/hour	ND	ND	ND
TCDD, (dioxin) Pounds/hour	ND	ND	ND

TCDF, (furan), Pounds/hour	ND	ND	ND
RCl (Volatile Chlorinated Organics)* Pounds/hour	3.91 (10^{-5})	3.19 (10^{-4})	2.18 (10^{-4})

*Quality control blanks not exposed to the stack were found to contain the same chlorinated organics at the same order of magnitude or higher. This leads RECON to believe the apparent emissions reported here are erroneous and in fact may be zero. The source of these organics may be the contaminated site itself or the diesel engines running during the testing, but no conclusions can be drawn.

The soil was fed to the incinerator at the rate of:

Soil, Pounds/hour	960	1023	999

The soil contained significant moisture content:

% Mositure	13.75	12.81	15.72

ND = None detected, less than value shown (value may be elsewhere in the report).

≥ = greater than or equal to

ppb = parts per billion; on wet sample unless otherwise noted.

ppmv = parts per million, by volume; on wet gas unless otherwise noted.

CERTIFICATION

This report is submitted by:

Richard F. Toro, M.Ch.E. Executive Vice President	Frank W. Swetits, Manager Field Testing

I am responsible charge of RECON's stack test work, and have discussed and reviewed the procedures and results of this set of tests with the relevant field and laboratory personnel.

Norman J. Weinstein, Ph.D., P.E.
New Jersey License 19536

STACK VELOCITY AND FLOW RATE DATA

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
Time	0935-1220	1015-1320	1530-1835
Stack Diameter, in	20	20	20
Stack Cross Section, sq. ft.	2.18	2.18	2.18
Barometric Pressure, "Hg	29.50	30.10	30.10
Average Stack Temperature, ^{o}F	155	148	149
Stack Pressure, "H_2O	0.02	0.03	0.03
Moisture, %	26.89	23.32	24.83
Average Velocity, ft./sec.	15.42	16.66	16.45
Actual Flow Rate, acfm	2020	2180	2150
Standard Flow Rate, scfm	1710	1910	1880
Dry Standard Flow Rate, dscfm	1250	1470	1420

Standard Conditions are $70^{o}F$, 29.92 "Hg

STACK GAS COMPOSITION

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
Time	0935-1220	1015-1320	1530-1835
		% By Volume (Dry Basis)	
ONSITE FYRITE			
CO_2	9.5	6.5	6.7
O_2	11.5	12.0	12.0
N_2 (By Difference)	79.0	81.5	81.3
LAB ANALYSIS**			
CO_2	9.0*	7.2	7.0
CO	0.625*	0.0001	0.0001
O_2	8.0*	10.0	10.8
N_2 (By Difference)	82.375*	82.8	82.2

*Average of two measurements.

**Carbon monoxide analysis by Thermo Electron Model 48, non dispersive infrared analyzer. The carbon dioxide and oxygen analyses were by orsat.

PARTICULATE, HYDROGEN CHLORIDE, TCDD, TCDF, POHC AND OTHER PESTICIDE EMISSIONS (MM5 TRAIN)

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
Time	0935-1220	1015-1320	1530-1835
SAMPLING DATA			
Nominal Nozzle Size (in)	1/4	1/4	1/4
No. of Sampling Points	12	12	12
Sampling Time, min	150	180	180
Sample Volume, dscf	33.63	43.93	42.26
% Isokinetic	109.7	109.9	109.3
EMISSIONS DATA			
Particulates			
Pounds/hour	0.226	0.135	0.159
Grains/dscf	0.0210	0.0107	0.0131
Grains/dscf @ 7% O_2	0.0226	0.0136	0.0180
Hydrogen Chloride			
ppmv (wet)	0.44	0.75	4.79
Pounds/hour	4.26×10^{-3}	8.15×10^{-3}	5.11×10^{-2}
POHC's			
a-BHC, Pounds/hour	8.21 (10^{-6})	ND 2.13 (10^{-6})	0.557 (10^{-6})
P,P'-DDT, Pounds/hour	ND 5.13 (10^{-7})	ND 1.28 (10^{-7})	ND 1.72 (10^{-6})
TCDD/TCDF			
TCDD, Pounds/hour	ND 2 (10^{-9})	ND 2 (10^{-9})	ND 1 (10^{-9})
TCDF, Pounds/hour	ND 1 (10^{-9})	ND 1 (10^{-9})	ND 1 (10^{-9})

Other Pesticides

g-BHC	1.28 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
B-BHC	1.28 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
Heptachlor	1.28 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
d-BHC	1.28 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
Aldrin	1.28 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
Heptachlor Epoxide	2.57 (10^{-5})	8.54 (10^{-5})	4.29 (10^{-7})
Endosulfan I	2.57 (10^{-5})	8.54 (10^{-5})	8.58 (10^{-7})
DDE	1.28 (10^{-5})	8.54 (10^{-5})	8.58 (10^{-7})
Diendrin	2.57 (10^{-5})	8.54 (10^{-5})	8.58 (10^{-7})
Endrin	2.57 (10^{-5})	8.54 (10^{-5})	8.58 (10^{-7})
Endosulfan II	2.57 (10^{-5})	8.54 (10^{-5})	1.72 (10^{-6})
DDD	5.13 (10^{-5})	8.54 (10^{-5})	1.72 (10^{-6})
DDT	5.13 (10^{-5})	1.28 (10^{-6})	1.72 (10^{-6})
Endrin Aldehyde	5.13 (10^{-5})	4.27 (10^{-4})	1.72 (10^{-6})
Endosulfan Sulfate	1.03 (10^{-4})	4.27 (10^{-4})	1.72 (10^{-6})
Methoxychlor	2.57 (10^{-4})	2.13 (10^{-3})	8.58 (10^{-6})
Chlordane	2.57 (10^{-4})	2.13 (10^{-3})	8.58 (10^{-6})
Toxaphene	2.57 (10^{-3})	2.13 (10^{-2})	8.58 (10^{-5})

VOLATILE CHLORINATED ORGANIC (RCl) EMISSIONS (VOST TRAIN)

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
Time	1118-1158 1240-1320 1335-1415	1014-1054 1108-1148 1203-1243	1549-1629 1644-1724 1735-1815
SAMPLING DATA			
Nozzle	NONE	NONE	NONE
No. of Sampling Points	1	1	1
Sampling Time, min	120	120	120
Sample Volume, dscf	2.04	2.20	2.22
EMISSION DATA (Pounds/hour)			
Methylene Chloride	3.91 (10^{-5})	7.07 (10^{-5})	1.08 (10^{-4})
Trichlorofluoromethane	ND	7.10 (10^{-5})	6.37 (10^{-5})
Tetrachloroethylene	ND	1.71 (10^{-5})	6.41 (10^{-6})
1,1,2-Trichlorotri-fluoroethane	ND	1.55 (10^{-4})	3.80 (10^{-5})
1,1,1-Trichloroethane	ND	5.02 (10^{-6})	2.01 (10^{-6})
TOTAL OF THE ABOVE	3.91 (10^{-5})	3.19 (10^{-4})	2.18 (10^{-4})

NOTE: Quality control blanks not exposed to the stack were found to contain the same chlorinated organics at the same order of magnitude or higher. This leads RECON to believe the apparent emissions reported here are erroneous and in fact may be zero. The source of these organics may be the contaminated site itself or the diesel engines running during the testing, but no conclusions can be drawn.

CONTAMINATED SOIL ANALYSES

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
Bulk Density, Pounds/cubic foot	83.0	84.9	86.1
Heating Value, btu/pound	<100	<100	<100
Ultimate Analysis (% Dry Basis)			
Carbon	1.07	1.01	0.64
Hydrogen	1.15	1.19	0.97
Nitrogen	0.05	0.05	0.04
Oxygen by difference	1.62	1.49	3.21
Sulfur	0.13	0.12	0.13
Organic Chlorine	0.15	0.10	0.28
Ash	95.83	96.04	94.73
	100.00	100.00	100.00
POHC Pesticides Content (ppb, Dry Basis)			
a-BHC	198,900	206,800	131,800
P,P'-DDT	129,600	200,600	29,670
Other Pesticides Content (ppb, Dry Basis)			
g-BHC	34269	26393	20825
B-BHC	45282	40726	22711
Heptachlor	54895	23617	11756
d-BHC	78215	39127	26054
Aldrin	330	330	330
Heptachlor Epoxide	330	330	330
Endosulfan I	330	330	330
DDE	5071	6194	7835
Diendrin	3567	4206	4187
Endrin	330	330	330
Endosulfan II	7241	12740	2008
DDD	111665	117846	181366
Endrin Aldehyde	330	330	330
Endosulfan Sulfate	330	330	330

TREATED SOIL ANALYSES

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
POHC Pesticides Content (ppb, Dry Basis)			
a-BHC	1.8	ND 2.5	ND 0.5
P,P'-DDT	ND 2.0	ND 2.0	ND 2.0
Other Pesticides Content (ppb, Dry Basis)			
g-BHC	ND 0.5	ND 2.5	ND 0.5
B-BHC	ND 0.5	ND 0.5	ND 0.5
Heptachlor	ND 0.5	ND 0.5	ND 0.5
d-BHC	ND 0.5	ND 0.5	ND 0.5
Aldrin	ND 0.5	ND 0.5	ND 0.5
Heptachlor Epoxide	ND 0.5	ND 0.5	ND 0.5
Endosulfan I	ND 1	ND 1	ND 1
DDE	ND 1	ND 1	ND 1
Diendrin	ND 1	ND 1	ND 1
Endrin	ND 1	ND 1	ND 1
Endosulfan II	ND 2	ND 1	ND 1
DDD	ND 2	ND 2	ND 2
Endrin Aldehyde	ND 2	ND 2	ND 2
Endosulfan Sulfate	ND 2	ND 2	ND 2
Methoxychlor	ND 10	ND 10	ND 10
Chlordane	ND 10	ND 10	ND 10
Toxaphene	ND 100	ND 100	ND 100
Dioxin/Furan Content (ppb, Dry Basis)			
TCD Dioxin	ND 0.17	ND 0.04	0.069
TCD Furan	ND 0.1	ND 0.031	0.036

PERFORMANCE DETERMINATIONS

Run No.	1	2	3
Date	12/10/86	12/11/86	12/11/86
POHC Removal From Soil			
a-BHC, Inlet ppb	198,900	206,800	131,800
a-BHC, Outlet ppb	1.8	ND 2.5	ND 0.5
a-BHC, % Removal	99.9991	$\geq$ 99.9988	$\geq$ 99.9996
P,P'-DDT, Inlet ppb	129,600	200,600	29,670
P,P'-DDT, Outlet ppb	ND 2.0	ND 2.0	ND 2.0
P,P'-DDT, % Removal	$\geq$ 99.9985	$\geq$ 99.9990	$\geq$ 99.9933
Destruction/Removal Efficiency (DRE)			
a-BHC, Inlet Pounds/hour	0.1647	0.1844	0.1110
a-BHC, Stack Pounds/hour	8.21 (10^{-6})	ND 2.13 (10^{-6})	0.557 (10^{-6})
a-BHC, % DRE	99.9950	$\geq$ 99.9988	99.9995
P,P'-DDT Stack, Pounds/hour	0.1073	0.1789	0.0250
P,P'-DDT Stack, Pounds/hour	ND 5.13 (10^{-7})	ND 1.28 (10^{-7})	ND 1.72 (10^{-6})
P,P'-DDT % DRE	$\geq$ 99.9995	$\geq$ 99.9993	$\geq$ 99.9931
HCl Removal Efficiency			
Equivalent HCl, Inlet Pounds/hour	1.48	1.05	2.88
HCl, Stack Pounds/hour	0.00426	0.00815	0.00511
HCl, % Removal Efficiency	99.71	99.22	99.82
Combustion Efficiency			
Carbon Dioxide, % Dry	9.0	7.2	7.0
Carbon Monoxide, % Dry	0.625	0.0001	0.0001
Combustion Efficiency, % ($\frac{CO2}{CO + CO2}$)	93.506	99.999	99.999

Particulate Emissions

Particulates			
Grains/dscf	0.0210	0.0107	0.0131
% Oxygen	8.0	10.0	10.8
Oxygen Correction Factor			
$\left(\frac{14}{21-\% O_2}\right)$	1.077	1.273	1.373
Corrected Particulates,			
Grains/dscf	0.0226	0.0136	0.0180

TRIAL BURN PLAN EXCEPTIONS/MODIFICATIONS

The details of the testing procedures are outlined in the trial burn plan dated July 14, 1986.

Due to the operational characteristics as carried out at the burn site, various changes were made to the plan.

These are summarized in the following letter to the US EPA.

In particular, it should be noted that the various scrubber waters were not analyzed since the system was not in steady state, but rather a closed loop. Analyses under such conditions could not be interpreted. Propane was used instead of fuel oil, so it was not analyzed.

RECON SYSTEMS, INC.

Route 202 North, P.O. Box 460
Three Bridges, N.J 08887
201-782-5900

New England 617-752-4217 Pennsylvania 215-433-5511

January 19, 1987

Mr. P. Clyde Johnson
Staff Geologist
U. S. E.P.A. Technical Assistance Team
4329 Memorial Drive, Suite C
Decatur, GA 30032

RE: Vesta Technologies
The Pit, Aberdeen N.C.
RECON Project No. 2473

Dear Mr. Johnson:

A table has been set up to clarify the analyses we will be running on the samples that we took at Aberdeen, NC on the 10th and the 11th of December, 1986 from the test burn of contaminated soil by Vesta. Changes in the analyses to be performed and types of samples to be analyzed were made from the original protocol after observing and discussing incinerator operation. All samples that were taken during the testing period, whether on the list to be analyzed or not (of which you have duplicates), will be held for 90 days after report submittal. Certain types of samples, though omitted from the original protocol, could contribute to, or contain contaminants from the system and will be analyzed for these contaminants. Other types of samples seemed not to have any way to contribute or detract from the contaminant concentration in the system. An example of the types of samples that are going to be held but not analyzed is the "purge water" which, after observing and discussing the system operation, turned out to be scrubber water in a closed loop system.

Below is a table describing the sample type, whether sample was combined with other samples, etc.

Sample Type (amount)	Analysis
Ash (3)	TCDD/TCDF Organic Pesticides Density
Solids (3)	Organic Pesticides Density Heat Content Moisture Ash Content Organic Chlorine Sulfur Elemental Composition (CHN) Total Volatile Organics
Stack gas MM-5: Filter & Probe Rinse (3) Field Blank Filter & Probe Rinse (1)	TCDD/TCDF Organic Pesticides HCl Particulates
Impinger & Condensate(3) Field Blank 5% KOH and distilled water	TCDD/TCDF Organic Pesticides HCl
Florisil & XAD-2 Sorbent*(3) Field Blank Sorbent set*(1) Trip Blank Sorbent set(1)	TCDD/TCDF Organic Pesticides

* Extracts from sorbent samples were combined with extracts from filter and probe rinse samples for dioxin and pesticide determinations. The field blank was treated in the same manner.

Stack gas VOST:	
Condensate & Probe Rinse(3)	Volatile Organics
Field Blank DI Water (1)	Volatile Organics
Tenax/charcoal cartridges (9)	Volatile Organics
Field Blank Tenax/ charcoal cartridges (3)	Volatile Organics
Trip Blank Tenax/ charcoal cartridge (1)	Volatile Organics

Please forward a copy of this to any of the appropriate parties involved in this project. Should there be any questions or any other concerns please do not hesitate to give me a call at 1-201-782-5900. Thank you for your assistance in this matter and we look forward to hearing from you.

Sincerely,

Patrick Mulrooney
Manager Instrument Lab

PAT/clo
cc: Patrick Phillips

Time = military time
min = minutes
^{o}F = degrees Fahrenheit
^{o}C = degrees Centigrade
"H_2O = inches water (pressure or vacuum)
"Hg = inches mercury (pressure or vacuum)
mm Hg = millimeters of mercury (pressure or vacuum)
psig = pounds of pressure per square inch-gage
sq ft = square feet
in = inches
micron = 10^{-6} meters
ft/sec = feet per second
ft/min = feet per minute
acfm = cubic feet per minute of total gas flow at flowing conditions
scfm = cubic feet per minute of total gas flow at 70°F, 29,92"Hg
lb/hr = pounds per hour
lb/hour pounds per hour
BTU/hr = British thermal units per hour
% = volume per cent when referred to gases and water vapor = weight percent for solids, liquids
% vol = volume per cent
% wgt = weight percent
ppmv = volumes of gaseous contaminants per million volumes of total gas
grains = grams x 15.4
ug = micrograms = 10^{-6} grams
mg = milligrams = 10^{-3} grams
grains/dscf = grains of pollutants per cubic foot of dry stack gas at 70°F, 29.92 "hg
gr/dscf = grains/dscf
ug/m^3 = micrograms of pollutants per cubic meter of total stack gas at 25°C, 760 mm Hg
mg/l = milligrams/liter of liquid = ppm by weight if specific gravity of liquid = 1.0
C = elemental carbon
CO_2 = carbon dioxide
H = elemental hydrogen
H_2 = molecular hydrogen
H_2O = water
N = elemental nitrogen
N_2 = molecular nitrogen
NO_x = NO + NO_2 = nitric oxide plus nitrogen dioxide reported as equivalent nitrogen dioxide.
S = elemental sulfur
SO_2 = sulfur dioxide
SO_3 = sulfur trioxide
SO_4 = sulfate
H_2SO_4 = sulfuric acid
H_2S = hydrogen sulfide
Cl = elemental chlorine or chloride
HCl = hydrogen chloride
F = elemental fluorine or fluoride
CH_4 = methane
O = elemental oxygen
O_2 = molecular oxygen
A = argon
< = less than; represents the minimum detectability limits
$\leq$ = equal to or less than
ND = none detected
Front half (dry catch particulate) - particulate matter collected in/on nozzle, probe, cyclone, flask heated hose, and filter of EPA sampling train
Back Half (wet catch particulate) - material collected in impingers after filter of EPA sampling train
Organic wet catch = residue after low temperature (70°F) evaporation of ether/chloroform used to extract soluble materials from the wet catch
Aqueous wet catch = residue after high temperature (220°F) evaporation of water left after ether/chloroform extraction
Combustibles = volatiles = loss on heating @ 550°C after drying @ 100°C
Ash = residue after heating @550°C.

PERSONNEL AND CLIENT OBSERVERS

RECON Field Test Personnel:	Peter F. Marshall
	Frank W. Swetits
	Patrick J. Mulrooney
	C. David Ruff
	Peter L. Rosen
	William L. Hart
Client Personnel:	Patrick Phillips
Observing Agencies:	US EPA
Agency Personnel:	Ned Jessup
	P. Clyde Johnson

EPA/540/2-89/030

SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

NUS Corporation. "Leetown Pesticide Site Treatability Study." Four progress reports in internal memorandum form. 62 pp. (total). Written under EPA Contract. July 1986 - January 1987.

EPA LIBRARY NUMBER:

Superfund Treatability Clearinghouse - EZUU

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Biological - Aerobic and Anaerobic
Media:	Soil/Generic
Document Reference:	NUS Corporation. "Leetown Pesticide Site Treatability Study." Four progress reports in internal memorandum form. 62 pp. (total). Written under EPA Contract. July 1986 - January 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	William Hagel Regional Project Manager U.S. EPA - Region III 841 Chestnut Street Philadelphia, PA 19107 215-597-9800
Site Name:	Leetown Pesticide Site, Leetown, WV (NPL)
Location of Test:	NUS, Pittsburgh, PA

BACKGROUND: This document is composed of a series of progress reports pertaining to a bench-scale treatability study which utilized biodegradation to remediate pesticide contaminated soils (DDT and DDE) at the Leetown Pesticide NPL site. Treatment consisted of aerobic, anaerobic and fungal processes to biodegrade the DDT and DDE.

OPERATIONAL INFORMATION: Nutrients such as manure, sewage sludge and wood chips were added to the soils to promote the growth of microbes capable of degrading the pesticides. More than 400 biodegradation cells were used over 4 test periods. Efforts to control temperature, pH and moisture content were attempted during the study. One report states that DDT degradation appears to take place at 35^{o} under anaerobic conditions and that DDE degradation takes place in acidic media. The microbes used in the test were not specified but are indigenous to the site. Baseline DDT and DDE levels were approximately 7,000 ug of DDT per Kg soil and 1000 ug of DDE per Kg of soil.

An extraction procedure with hexane done on the soil to analyze for DDT was criticized for being a quick and dirty extraction with no cleanup of the extract. Other concerns reported were strongly sorbed compounds may not be detected, interference from naturally occurring organic matter could skew the results and lack of standard analytical protocols could introduce extraneous variables into the data. Specific information pertaining to the quantity or type of contaminated soils was not included in the report.

PERFORMANCE: In December of 1986 an analysis of variance (ANOVA) of the results was conducted to determine if there is any statistically significant difference between the various samples collected from each of the different treatment cells and to determine if there is a significant difference in DDT and DDE concentrations from one cell treatment to the next. The ANOVA indicated there is no significant difference between the

various cell configurations. Hence the average concentration calculated for each cell configuration is representative of the population mean. A review of the sampling data reported in the December 30th progress report suggests that anaerobic vessels operating under incubated conditions represented the best method of degrading DDT in the soils. The authors report that the indigenous microbial populations can be used to degrade DDT at the Leetown Pesticide Site. A preliminary estimate of the time for this process to reduce DDT plus DDE to desired action levels of 300 ug/kg of total DDT and metabolites was 8 months. Both DDT and DDE are degraded under anaerobic conditions, and anaerobic vessels operating under incubated conditions represent the best method of degrading DDT. Further work was recommended on the toxicity and environmental mobility of the metabolites present from the recommended composting scheme as well as controlled bench and pilot testing.

No QA/QC procedures were reported; however, quality control issues were discussed and this work was done under an EPA contract.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminant
W01-Halogenated Nonpolar Aromatic Compounds	50-29-3	1,1,1-trichloro-2,2-bis (4-chlorophenyl)ethane (4,4-DDT)
	72-55-9	1,1-dichloro-2,2-bis (4-chlorophenyl)ethene (4,4-DDE)

NUS CORPORATION

INTERNAL CORRESPONDENCE

Rec'd 7-27-87
@ 2:56 pm
C-34-7-6-113
William Hagel E
EPA-Reg 3
9SO-TSI-RT-EZUU

TO: FILE

DATE: JULY 9, 1986

FROM: ROBERT J. HUBBARD RJH

COPIES: D. BRENNEMAN
D. MACINTYRE
H. ROFFMAN
J. GEORGE

SUBJECT: LEETOWN PESTICIDE SITE TREATABILITY STUDY - PROGRESS REPORT
EPA WORK ASSIGNMENT NUMBER 65-3L52
NUS PROJECT NUMBER S794.14

A brief synopsis of the status of the Leetown Pesticide Site Treatability Study follows:

- One hundred and thirty (130) reaction vessels (biodegradation cells) were generated from June 25 through June 28, 1986.

- Twenty cells were deleted from the original scope of work as a result of the offensive nature of the matrix (i.e., odiferous aerobic sewage sludge cells were eschewed).

- Generation of all other cells proceeded without difficulty with the following exception: gypsum was found to be an inappropriate acidification substance. On reexamination is is recognized that this salt (calcium sulfate) is generated from both a strong base and a strong acid. Hence, the pH of the soil matrix achieved through addition of this substance was in the neutral range (pH = 6.5). Aluminum sulfate was substituted as an acidifier. Aluminum ions successfully compete with hydronium ions for available exchange sites. Soil reaction of pH = 4.5 was easily achieved through addition of aluminum sulfate.

- The heat input to the incubation vessel was gradually adjusted until a constant temperature of 94 ^{o}F was achieved. The aerobic reaction vessels experienced loss of soil moisture over the first four or five days of the study. This required addition of additional deionized water. This moisture loss has been mitigated through capping. Mason jar lids have been placed loosely over the vessels. The lids are removed once daily (during daily inspection) to introduce new air to the vessels.

- No loss of soil moisture is evident in the ambient (bench top) vessels. The pre-humidified air supplied to the enclosures is working as planned.

- To date, no evidence of gas generation is evident in any of the flooded (anaerobic) vessels.

- Evidence of growth of microorganisms is evident in a number of the aerobic cells, however. Mycelium are apparent in a number of the pH = 4.5 cells (i.e., the fungal cells). A crusty substance similar to a lichen in appearance has been noted in several of the pH = 7.0 cells. Although no evidence of degradation will be available until the first samples are analyzed in late July, the growth of the different organisms under the different conditions appears promising.

- The results for the initial (t = 0) samples are attached. Note the consistency in the results between replicates for each sample batch. This is considered an indication that the mixing process was thorough and adequate to assure statistically useful results.

A lab logbook is being kept that contains more detailed information regarding the study. I have learned that our laboratory has an NRC license, thus we should have no difficulty in obtaining the radiolabeled pesticides for the carbon 14 study. As indicated in the work plan, this phase of the study will not be undertaken until the results at the end of the first 30-day period (approximately July 30) have been obtained. This should give us some insight as to which combination of variables warrants more explicit study.

NUS CORPORATION
PARK WEST TWO
CLIFF MINE ROAD
PITTSBURGH, PENNSYLVANIA 15275-1071
(412) 788-1080

C-34-8-6-182

August 14, 1986

NUS Project No. S794.14

Ms. Laura Booranzian
Regional Site Project Officer
U.S. Environmental Protection Agency
Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

Subject: Leetown Pesticide Site, WV
EPA Work Assignment No. 95-3L52.1
Treatabilty Study Status Meeting -
August 13, 1986

Dear Laura:

This correspondence includes a brief summary of the points raised during our meeting on August 13, 1986, regarding the ongoing treatability study of microbial degradation of pesticides in the Leetown Site soils. This meeting was attended by the following:

Ms. Laura Boornazian	EPA Region III Regional Site Project Officer
Dr. Richard Brunker	EPA Region III Toxicologist
Mr. Robert Hubbard	NUS Chemical Engineer, Technical Project Lead
Mr. John George	NUS Project Manager

Dr. Brunker generally approved of the experimental set-up in the NUS Laboratory Services (LSD) facility, and of the manner in which Mr. Hubbard had documented the study thus far. One area of concern appeared to be the assurance that soil reaction (pH) in the test cells was being adequately maintained. NUS should verify that the buffers used remain effective in maintaining the desired pH over the course of the study by periodic pH measurements. In addition, NUS should validate the procedure used to determine soil pH; in particular, NUS should investigate whether the quantity of soil used in making up the slurry for pH testing has any bearing on the pH measured. Cells should also be configured and exposed to sunlight to test the utility of photolytic degradation of the pesticides as a treatment technology. This will be done by placing soil in aluminum roasting pans, covered with a celophane wrap and exposing them to sunlight with frequent mixing of the soils.

Administratively, we agreed that NUS would continue the present study, with sample collection from the cells at the end of August and during mid-September, in anticipation of possible termination or interruption of the study with the close of the REM/FIT Contract on September 30. The EPA trailer which houses the GC used in analyzing the samples will be returned to the EPA

in mid-September. An adequate allowance will be made in scheduling sample collection in September to ensure that these samples can be analyzed via the EPA lab. NUS is investigating the possible use of a similar GC owned by NUS and presently onsite in Michigan. Under REM III, use of this equipment requires negotiation of a rental rate with EBASCO and the EPA.

Although preliminary quantitative results were incomplete from the analysis of the first set of soil samples (t = 30 days), there appears to be some evidence of decay in the initial pesticide concentrations in some of the cells. Final preliminary quantitative results should be available by today. However, adequate data are not expected to enable NUS to establish a time rate of decay of the pesticides in order to determine whether the treatability study can be terminated with sample collection in mid-September. The likelihood is that at least some facet of the study will need to be continued beyond the end of the present REM/FIT Contract. It will be necessary for us to discuss the mechanism for transition of this work into REM III under EBASCO as soon as possible to avoid interruption of the work. I realize, however, that no firm commitments can be made by the Agency until the issue of Superfund reauthorization is resolved.

We committed to submittal of a report of the initial and t = 30 days analytical results within approximately two weeks.

The remainder of our meeting was devoted to a discussion of the experimental protocols for the radio-isotope study. Dr. Brunker indicated that the protocols presented by Mr. Hubbard, based on a search of the literature, appeared to be appropriate to the study. The issue of what material to use to trap the CO_2 off-gas (e.g., potassium hydroxide, phenylethylamine) should be resolved by contacting applications personnel at New England Nuclear. NUS should be aware that the CO_2 trapping material may react with the scintillation cocktail to produce "chemoluminesence" which may result in aberrant (high) scintillation counts. The occurrence of this phenomenon will be evaluated initially by conducting "aged" counts on a single sample to see if counts drop off after time, indicative of the phenomenon.

We then discussed the amount of the isotope to use. NUS will be obtaining uniformly ring-labeled DDT and DDE. Approximately one micro-Curie of each will be obtained. When ready for use, the radio-isotopes will be mixed with distilled water and diluted to a concentration sufficient to produce about 100 counts per minute (cpm) in the CO_2 collected. The actual amount of the isotope/distilled water mixture to be added to the soil samples will be dependent upon the concentration of the mixture, the assumed decay rate (and thus the labeled CO_2 generation rate) of the pesticides, and the interval over which the CO_2 trap will remain in contact with the atmosphere in the reaction vessel between scintillation counts. Mr. Hubbard will make the necessary calculations after he has had an opportunity to review the initial analytical results relative to the decay rate of the pesticides, and will submit them to Dr. Brunker for review.

The estimated duration of the radio-isotope study will be about 30 days. Counts will be made daily for the first week, and the interval between CO_2 sample colllections will be adjusted thereafter based on the data obtained. A minimum of two replicates of each treatment cell will be configured. Initiation of the study is anticipated by the week of August 25. With this late date for initiation of the work, it is recognized that there is some risk that the study may have to be aborted without final completion near the close of the REM/FIT contract on September 30.

I understand from our conversation that EPA Region III is interested in having NUS continue on this project in a design and construction capacity. This was originally suggested in the context of the EPA "Contractor Continuity" Pilot Program. In terms of additional work beyond the bench scale treatability study, we discussed the need to engage in pilot-scale studies of the most promising treatments, possibly in conjunction with further-refined bench scale microbial degradation studies. It is possible that the pilot-scale studies could be initiated this winter. It will be important in scheduling of such studies, however, for us to be aware of the Superfund Comprehensive Accomplishments Plan (SCAP) commitments for the Leetown Site regarding design and construction.

Finally, I would like to take this opportunity to thank you and Dr. Brunker for taking the time to overview the treatability study set-up and to provide suggestions on the study.

Very truly yours,

John George
Project Manager

Approved for submission by:

David E. MacIntyre
Regional Manager of Projects

JAG/jag

cc: Ed Shoener, EPA Region III
Richard Brunker, EPA Region III
Lisa Woodson, EPA Headquarters

NUS CORPORATION

INTERNAL CORRESPONDENCE

C-34-8-6-384

TO: FILE

DATE: AUGUST 29, 1986

FROM: ROBERT J. HUBBARD RJH

COPIES: D. BRENNEMAN
D. SENOVICH
D. MACINTYRE
H. ROFFMAN
J. GEORGE

SUBJECT: LEETOWN PESTICIDE SITE TREATABILITY STUDY - PROGRESS REPORT #2
EPA WORK ASSIGNMENT NUMBER 65-3L52
NUS PROJECT NUMBER S794.14

Reaction vessels were configured from June 25 through June 28, 1986 to study the biodegradation of DDT and DDE by indigenous soil microorganisms. The influence of pH, soil moisture, temperature, and various soil amendments on the activity of such organisms was considered in devising the experimental design. Additional details are included in the file memo dated July 9, 1986 (C-34-7-6-113).

A sample was collected from each reaction vessel during the week of July 28, 1986. Samples were extracted and analyzed by Debra M. Scheib, using the gas chromatograph in the mobile laboratory. Holding time requirements for pesticide/PCB analysis (as specified under the EPA's Contract Laboratory Program) were satisfied.

Baseline (t=0) concentrations were determined at the time the cells were generated. The analytical results of the baseline analyses, as well as the results of the first sampling round (t=30 days) are included in the attachments.

Table 1 summarizes average values of the "degradation ratio" for all of the cell configurations (5 individual cells comprise each configuration). The degradation ratio was devised to facilitate a statistical analysis and is simply the concentration of DDT and DDE at time t=30 days divided by the concentration of the respective analyte at time t=0. Note that some of these values exceed unity. This is considered evidence of the heterogeneous nature of the pesticide contamination. However, increases in DDE concentrations were noted in a number of the anaerobic cells, and this is not believed to be result of matrix effects (as discussed further below).

The results were subjected to a statistical treatment (Analysis of Variance) to confirm or negate the null hypothesis (i.e., to determine if variance in sample means was caused by random fluctuations attributable to sampling and analysis). The results of the F-test indicated that variance in sample means is significant in all of the sets at a minimum level of significance of 0.05. Variance is significant in a number of the cells at much lower probability levels (i.e., as low as 0.005). The statistical treatment is outlined in detail in the attached sample calculation package. Table 2 summarizes experimental F values and literature F values for each of the sample populations considered.

Although it is apparent that non-homogeneity of contamination in the soil matrix may have had some effect on the results, several trends are evident in the analytical data that provide information regarding the applicability of various treatment techniques at the Leetown Site. Several of the treatment cells displayed favorable results for the degradation of both DDT and DDE. The composition of these cells will be used as a basis for configuration of cells for additional study using radio-labeled pesticides (i.e., ring-labeled DDT and DDE).

Results at 30 days should be considered an initial indication of the success, or lack thereof, in achieving degradation. At this phase of the study only a qualitative indication of promising degradation avenues is necessary. Quantitative results will be provided by the carbon 14 study through scintillation counts (if complete mineralization occurs) or through thin layer chromatography (if complete breakdown to carbon dioxide and water is not observed).

Figure 1 displays a schematic representation of the experimental design. Three main branches of the experiment are shown: a fungal degradation branch; an aerobic bacterial degradation branch; and an anaerobic bacterial degradation branch. The analytical results for each of these is discussed briefly below.

Fungal Branch (pH=4.5)

Several of the cell configurations for this branch gave favorable results for the degradation of both DDT and DDE. It was observed that the best results occurred in the cells containing only the natural soil. A possible hypothesis is that the presence of alternate food sources (such as the organic material in manure) inhibits the action of the low pH-favoring soil microorganisms on the pesticide compounds. It appears that increasing the temperature of the vessels is detrimental to the performance of the organisms in these cells.

Aerobic Bacterial Branch (pH=7)

Favorable results were also observed in several of these cells. In contrast to the fungal cells, microorganisms operating under these conditions appear to perform better in the presence of alternate food sources. It is speculated that population growth is more pronounced for organisms in these cells, and that they compete for any available organic molecules, including the pesticides. It should be noted that most of the literature reports that aerobic bacteria are incapable of degrading DDT. However, it should be recognized that these species reside in an area with high background levels of these organochlorine pesticides. They are expected to be at least tolerant of these chemicals and have hopefully developed the capacity to enzymatically degrade them.

Some indication that degradation is favorable at higher temperatures is offered by the results. However, this evidence is not considered conclusive at this time. Difficulties were experienced in maintaining the soil moisture of the incubated vessels, and deionized water was added to the cells on several occasions. Because of the problems with dessication, results may be less conclusive than those operating under ambient

conditions. The ambient cells have not required the addition of moisture during the period of study.

Anaerobic Cells

Degradation of DDT was evident in several of these cells and appears to occur more rapidly at elevated temperatures. This is consistent with observations in the lab. The incubated anaerobic cells were generating gas at a much earlier date than the cells at room temperature (most of the ambient cells are still not evolving gas). DDE concentrations increased in a number of these cells (when contrasted with the baseline concentrations for the amended soil matrix). This was also observed for DDT in a number of the cells. For this reason it was considered likely that the baseline concentrations were somewhat lower than the true values and therefore the results from the thirty day samples were also contrasted with the baseline concentrations for the natural soil. Although DDE concentrations were generally lower when contrasted in this manner, they still did not indicate that any significant degradation has transpired. Overall, these results are consistent with other studies that have shown DDE to be a predominant degradation product of DDT under anaerobic conditions.

Summary

Based on the initial results of the degradation study, the anaerobic branch appears unsuitable for degrading both DDT and DDE. Some promise is evident for various aerobic configurations. The aerobic branches will be included in the radio-labeled pesticide study. Pending the concurrence of USEPA Region III, the following cells will be configured for the second phase of the study: low pH cells (i.e., pH approximately 4.5) without soil amendments and neutral pH cells (both amended and unamended cells).

bcc: Laura Boornazian (EPA Region III)
Richard Brunker (EPA Region III)

TABLE 1
Page 1

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)*

Fungal Cells (pH=4.5)

Cell Matrix	DDT	DDE
Soil Room Temperature	0.23	0.10
Soil T=35°C	0.25	1.67
Manure (5% by weight) Room Temperature	0.48	0.17
Manure (5% by weight) T=35°C	0.35	0.35
Manure (10% by weight) Room Temperature	0.66	0.19
Manure (10% by weight) T=35°C	1.31	1.36
Manure & Wood Chips (5% by weight) Room Temperature	0.38	0.11
Manure & Wood Chips (5% by weight) T=35°C	0.47	0.18
Manure & Wood Chips (10% by weight) Room Temperature	0.54	0.34
Manure & Wood Chips (10% by weight) T=35°C	1.06	1.23

Table 1
Page 2

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)

Anaerobic Cells (Flooded, pH=7)**

Cell Matrix	DDT	DDE
Soil Room Temperature	0.71	0.31
Soil T=35°C	0.198	0.70
Manure (5% by weight) Room Temperature	2.06	0.98
Manure (5% by weight) T=35°C	0.33	1.62
Manure (10% by weight) Room Temperature	2.69	0.97
Manure (10% by weight) T=35°C	0.31	1.52
Anaerobic Sewage Sludge (5% by weight) Room Temperature	1.06	1.74
Anaerobic Sewage Sludge (5% by weight) T=35°C	0.28	1.59
Anaerobic Sewage Sludge (10% by weight) Room Temperature	1.16	1.43
Anaerobic Sewage Sludge (10% by weight) T=35°C	0.65	2.69

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)

Anaerobic Cells (Flooded, pH=7)***

Cell Matrix	DDT	DDE
Soil Room Temperature	0.71	0.31
Soil T=35°C	0.198	0.70
Manure (5% by weight) Room Temperature	0.53	0.3
Manure (5% by weight) T=35°C	0.084	0.49
Manure (10% by weight) Room Temperature	0.43	0.32
Manure (10% by weight) T=35°C	0.052	0.51
Anaerobic Sewage Sludge (5% by weight) Room Temperature	0.22	0.36
Anaerobic Sewage Sludge (5% by weight) T=35°C	0.059	0.33
Anaerobic Sewage Sludge (10% by weight) Room Temperature	0.25	0.53
Anaerobic Sewage Sludge (10% by weight) T=35°C	0.14	1.00

Table 1
Page 4

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)

Aerobic Cells (pH=7)**

Cell Matrix	DDT	DDE
Soil Room Temperature	0.159	0.999
Soil T=35°C	0.352	0.751
Manure (5% by weight) Room Temperature	0.135	0.073
Manure (5% by weight) T=35°C	0.679	0.391
Manure (10% by weight) Room Temperature	0.341	0.153
Manure (10% by weight) T=35°C	0.115	0.10

Notes:

* - DR=(C_{DDT} @ t = 30 days)/(C_{DDT} @ t = 0)

** - Results based on baseline concentration of amended soil

*** - Results based on baseline concentration of unamended soil

TABLE 2

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
EXPERIMENTAL VERSUS LITERATURE F VALUES

POPULATION	EXPERIMENTAL F		LITERATURE F		
	DDT	DDE	0.05	0.01	0.005
Fungal Cells	2.5	3.9	2.12	2.89	3.22
Anaerobic Cells$_1$ (Amended Conc)	7.9	2.8	2.12	2.89	3.22
Anaerobic Cells$_2$ (Unamended Conc)	6.5	2.2	2.12	2.89	3.22
Aerobic Cells	1.0	8.9	2.62	3.90	4.49
All Cells (Using 1)	5.9	5.0	1.70	2.12	2.29
All Cells (Using 2)	2.9	3.8	1.70	2.12	2.29

LEGEND

F –FLOODED CONDITIONS
M_1–MANURE
M_2–MANURE WITH WOOD CHIPS
S_1–AEROBIC SEWAGE SLUDGE
S_2–ANAEROBIC SEWAGE SLUDGE
N –NO AMENDMENTS

NOTE

10 REPLICATES OF EACH CELL WILL BE CONFIGURED; 5 WILL OPERATE AT 35°C; 5 WILL OPERATE AT APPROX. 20°C (AMBIENT CONDITIONS).

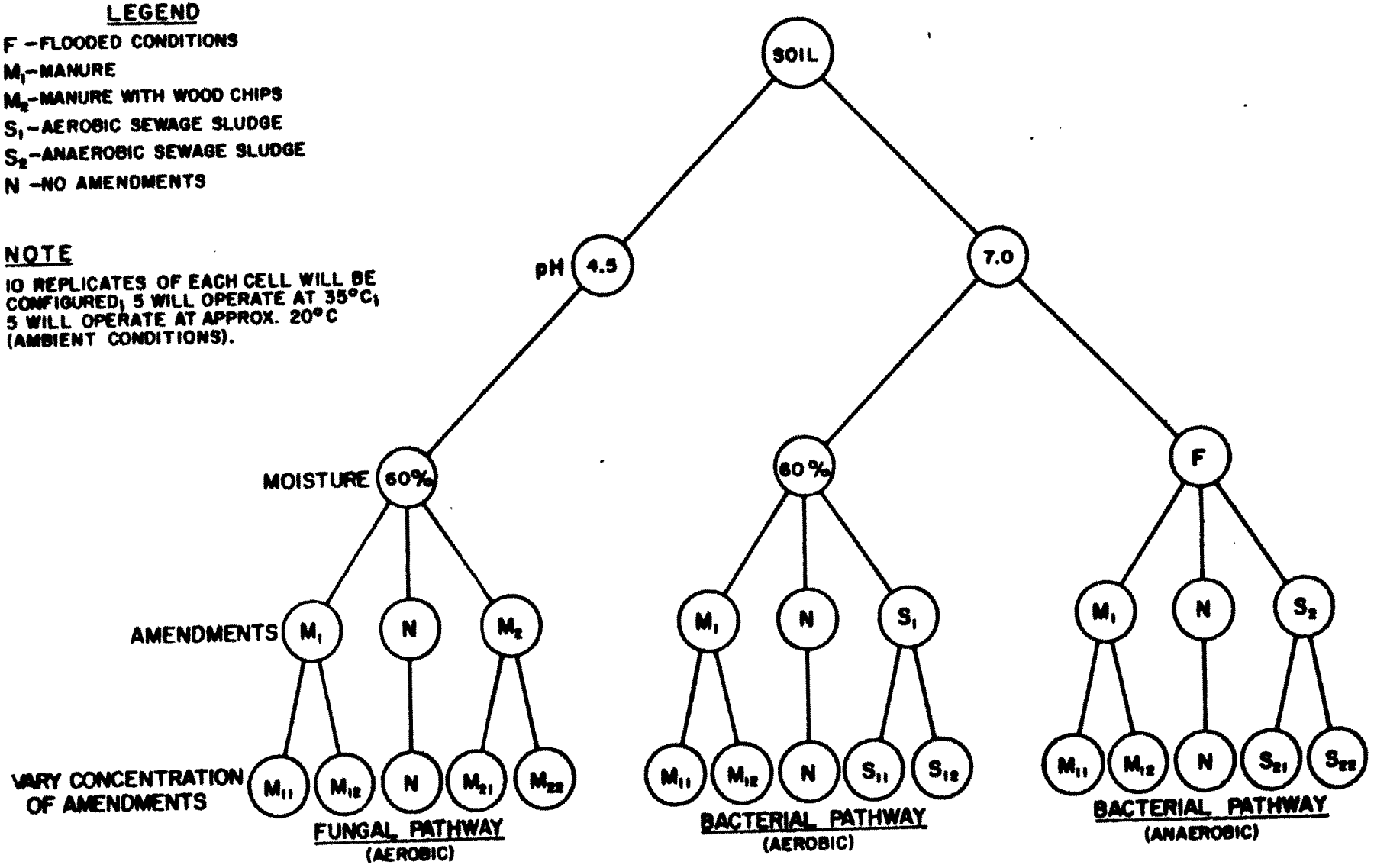

FIGURE 1

TREATABILITY STUDY CELL CONFIGURATION
LEETOWN PESTICIDE SITE, LEETOWN, WV

NUS CORPORATION
A Halliburton Company

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INTERNAL CORRESPONDENCE

C-34-9-6-43

TO: FILE

DATE: SEPTEMBER 29, 1986

FROM: ROBERT J. HUBBARD RJH

COPIES: D. BRENNEMAN
D. SENOVICH
D. MACINTYRE
H. ROFFMAN
J. GEORGE

SUBJECT: LEETOWN PESTICIDE SITE
TREATABILITY STUDY
PROGRESS REPORT #3
EPA WORK ASSIGNMENT NO. 65-3L52
NUS PROJECT NO. 794.14

A third round of samples were collected from the Leetown treatability study reaction vessels from September 5, 1986 through September 18, 1986. During the analysis of these samples, problems were encountered because of degradation of the chromatographic column. The column was replaced approximately halfway through the sampling and analysis program (September 12, 1986). This event extended the period of time necessary to complete the analytical work. No adverse effects on the analytical results are anticipated because of this problem.

Table 1 summarizes the analytical results for all samples collected to date. Included on the table are baseline results, results for the second sampling round at t = 30 days, and results for the third round at t = 60 days.

During the most recent round, results for some of the cells indicated that matrix effects are more severe than anticipated. The concentrations in several samples collected during the third sampling round were noted to be much higher than those determined during the second sampling round. Difficulties were especially pronounced in the cells containing 10% manure by weight (particularly those operating at the higher temperatures). The problems with these cells are clearly attributable to matrix interference effects.

Table 2 presents a summary of the "degradation ratio" for both the t = 30 day samples and the t = 60 day samples. The degradation ratios are simply the concentrations at t = 30 days and t = 60 days divided by the baseline (t = 0) concentration. Several points are evident from the degradation ratios presented in the table. It is apparent that the most promising results were obtained from the cells containing no amendments whatsoever. As discussed in Progress Report #2, this is considered evidence that the best degradation rates are achieved if alternate carbon sources are not available to the microorganisms. In addition, it is also apparent that the cells operating at ambient conditions also provide more favorable results. Difficulties encountered in maintaining the moisture levels in the incubated cells (T = $35^{o}C$) were not encountered in the cells operating at room temperature. It is felt that more meaningful results will be generated with the cells operating under ambient conditions. Since temperatures similar to those in the incubated cells (i.e., T = $35^{o}C$) will be difficult to achieve in the field, it is also felt that the ambient cells will provide results more consistent with the ultimate field application of the process.

Based on the results achieved to date, the general conclusion has been reached that the unamended samples (i.e., natural soil samples) operating at room temperature display the most promise. Based on these initial findings, a decision has been made to focus the remaining study on certain cells rather than on the entire group. During the fourth sampling round, samples will be collected from only the unamended (or natural soil) cells. With the exception of the anaerobic cells, only cells operating at room temperature will be sampled. Thus a total of 4 sets of cells will be sampled. Because of the desire to obtain more precise and representative results, 5 samples will be collected from each of the individual reaction vessels (5 vessels per treatment configuration). Thus a total of 100 samples will be collected during the fourth round. Similar samples will be collected during the 5th sampling round if funds are available at that time.

Contrast of the results obtained during the 4th and 5th sampling rounds originally proposed for October and November should provide final, conclusive evidence that substantial degradation has occurred in the selected cells.

Prior to expiration of the REM/FIT contract, the materials for the ^{14}C study were obtained. Labelled pesticides and biometric flasks were received from Pathfinder Laboratories, Inc. and Bellco Glass Company, respectively. This phase of the study will be implemented as soon as adequate funds are available to carry the isotopic study to completion.

RJH/rjh

Att.

DD ıd DDE CONCENTRATIONS AS A FUNCTION OF TIME

NS-4-R-A-1	NS-4-R-A-2	NS-4-R-A-3	NS-4-R-A-4	NS-4-R-A-5	NS-4-I-A-1	NS-4-I-A-2	NS-4-I-A-3	NS-4-I-A-4	NS-4-I-A-5	SMI-4-R-A-1	SMI-4-R-A-2	SMI-4-R-A-3	SMI-4-R-A-4	SMI-4-R-A-5
Nat'l Soil					Nat'l Soil					Manure				
pH = 4.5					pH = 4.5					5 Wt %				
Room Temp					T = 35°C					pH = 4.5				
										Room Temp				
$\bar{X}_1$ = 6822					$\bar{X}_1$ = 6822					$\bar{X}_1$ = 1758				
$\bar{X}_2$ = 772					$\bar{X}_2$ = 772					$\bar{X}_2$ = 235				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	7,600	7,380	5,050	6,870	6,810	7,600	7,700	5,050	6,870	6,810	1,730	1,210	1,980	1,830	2,040
t=30	305	[180]	5,420	1,700	300	440	550	805	3,630	3,020	[265]	2,020	365	445	1,120
t=60	[2205J]	520U	[2805J]	1,370 J	550U	3,760	2,300	715	1,420	950	385	850	1,035	590	465

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	1,260	470	545	455	1,120	1,260	470	545	455	1,120	305	240	240	170	220
t=30	BMDL	BMDL	390	BMDL	BMDL	3,300	1,520	300	650	570	BMDL	BMDL	BMDL	BMDL	[195]
t=60	190U	195U	195U	460J	205U	1,610	320	155	585	305	[60]	[60]	150	75	80

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

SMI-4-I-A-1	SMI-4-I-A-2	SMI-4-I-A-3	SMI-4-I-A-4	SMI-4-I-A-5	10MI-4-R-A-1	10MI-4-R-A-2	10MI-4-R-A-3	10MI-4-R-A-4	10MI-4-R-A-5	10MI-4-I-A-1	10MI-4-I-A-2	10MI-4-I-A-3	10MI-4-I-A-4	10MI-4-I-A-5
Manure 5 wt % pH=4.5 T=35°C $\bar{X}_1$ = 1758 $\bar{X}_2$ = 335					Manure 10 wt % pH=4.5 Room Temp $\bar{X}_1$ = 1099 $\bar{X}_2$ = 259					Manure 10 wt % pH=4.5 T=35°C $\bar{X}_1$ = 1099 $\bar{X}_2$ = 259				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	1,730	1,210	1,980	[830]	2,040	745	1,160	1,150	1,390	1,050	745	1,160	1,150	1,380	1,050
t=30	[880]		405	[280]	1,040	330	1,280	805 J	430 J	330	1,190	3,340	865	1,170	645
t=60	4,880	3,580	5,350	2,180	2,350 J	1,235	425	1,200	1,270	655	2,980	4,780	10,400	5,530 J	3,670

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	305	240	240	170	220	690	165	130	130	180	690	165	130	130	180
t=30	[175]		BMDL	BMDL	[150]	BMDL	250	BMDL J	BMDL J	BMDL	[125]	660	560	500	[180]
t=60	1,030	460	2,170	830	795	[590 J]	830 J	[135 J]	145 J	[45 J]	385	1,465	3,850	2,520	1,930

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

SM2-4-R-A-1	SM2-4-R-A-2	SM2-4-R-A-3	SM2-4-R-A-4	SM2-4-R-A-5	SM2-4-I-A-1	SM2-4-I-A-2	SM2-4-I-A-3	SM2-4-I-A-4	SM2-4-I-A-5	SM1-4-R-A-1	SM1-4-R-A-2	SM1-4-R-A-3	SM1-4-R-A-4	SM1-4-R-A-5
Mussel Chips 5 wt % pH = 4.5 Room Temp $\bar{X}_1$ = 4688 $\bar{X}_2$ = 875					Mussel Chips 5 wt % pH = 4.5 T = 35°C $\bar{X}_1$ = 4688 $\bar{X}_2$ = 875					Mussel Chips 10 wt % pH = 4.5 Room Temp $\bar{X}_1$ = 3806 $\bar{X}_2$ = 404				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	5,400	3,200	5,130	5,610	4,100	5,490	3,200	5,130	5,610	4,100	3,430	5,710	1,890	1,500	6,460
t=30	1,300	325	2,990	1,250	2,830	1,690	3,120	1,510	4,330 J	[270]	905	1,610	1,430	5,300	945
t=60	465	1,720	1,970	1,300	1,190	1,820	2,210	5,360	4,580	2,690	[600 J]	[350 J]	5,840 J	3,190 J	1,430 J

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	610	870	900	845	1,150	610	870	900	845	1,150	490	570	250	235	475
t=30	490	BMDL	BMDL	BMDL	BMDL	[220]	[215]	[190]	[175] J	BMDL	[200]	[155]	[190]	150	BMDL
t=60	[40 J]	[50]	835	155 J	[45]	380	435	885	660	530	[245 J]	[120 J]	[175 J]	[55 J]	[210 J]

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

KM2-4-I-A-1	KM2-4-I-A-2	KM2-4-I-A-3	KM2-4-I-A-4	KM2-4-I-A-4
Manure/Chips				
10wt%				
pH=4.5				
T=35°C				
$\bar{X}_1$ = 3806				
$\bar{X}_2$ = 404				

	DDT	DDT	DDT	DDT	DDT
t=0	3,470	5,710	1,890	1,590	6,460
t=30	1,700	6,025 J	3,180	1,540	1,880
t=60	1,440	3,500	5,000	2,580	

	DDE	DDE	DDE	DDE	DDE
t=0	490	570	290	235	475
t=30	[230]	815 J	695	[260]	475
t=60	440	1,540	2,200	330	

(B)

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

NS-7-R-A-1	NS-7-R-A-2	NS-7-R-A-3	NS-7-R-A-4	NS-7-R-A-5	NS-7-I-A-1	NS-7-I-A-2	NS-7-I-A-3	NS-7-I-A-4	NS-7-I-A-5	SMI-7-R-A-1	SMI-7-R-A-2	SMI-7-R-A-3	SMI-7-R-A-4	SMI-7-R-A-5
Natl Soil pH = 7.0 Room Temp					Natl Soil pH = 7.0 T = 35°C					Manure 5 wt % pH = 7.0 Room Temp				
Y_1 = 6822 Y_2 = 772					Y_1 = 6822 Y_2 = 772					Y_1 = 1,758 Y_2 = 235				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	3,600	3,780	5,050	6,870	6,810	3,600	3,780	5,050	6,870	6,810	1,330	1,210	1,980	1,830	2,040
t=30	500	395	1,730	1,730	1,060	1,630	2,570	4,250	1,300	2,240	[210]	1,020	1,520	1,080	350
t=60	385	695	3,650	1,250	840	5,930	3,120	1,700	530	2,910	4,280	785	350	740	410

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	1,260	470	545	455	1,130	1,260	470	545	455	1,130	305	240	240	170	220
t=30	BMDL	BMDL	[235]	BMDL	BMDL	445	345	900	[150]	610	BMDL	[105]	[135]	BMDL	BMDL
t=60	370	[55]	350	90	115	1,080	755	465	140	520	150	[70]	[50]	80	35

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

SMI-T-I-A-1	SMI-T-I-A-2	SMI-T-I-A-3	SMI-T-I-A-4	SMI-T-I-A-5	MMI-T-R-A-1	MMI-T-R-A-2	MMI-T-R-A-3	MMI-T-R-A-4	MMI-T-R-A-5	MMI-T-I-A-1	MMI-T-I-A-2	MMI-T-I-A-3	MMI-T-I-A-4	MMI-T-I-A-5
Manure 5 wt % pH = 7.0 T = 35°C I_1 = 1,358 I_2 = 235					Manure 10 wt % pH = 7.0 Room Temp I_1 = 1,095 I_2 = 259					Manure 10 wt % pH = 7.0 T = 35°C I_1 = 1,099 I_2 = 259				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	1,730	1,210	1,980	1,830	2,040	745	1,160	1,150	1,390	1,050	745	1,160	1,150	1,380	1,050
t=30	835	16,300	3,640	920	1,090	1,000	8,710	740	440	730	610	1,025	980	705	615
t=60	5,550	1,080	1,550	1,440	955	5,760	765	3,530	2,000	405	5,730	5,300	1	3,230	1,570
	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	305	240	240	190	220	690	165	130	130	180	690	165	130	130	180
t=30	[210]	[230]	660	[200]	[210]	[130]	[125]	[130]	[100]	[105]	[130]	[145]	[110]	BMDL	BMDL
t=60	1,220	300	345	275	275	940	120	165	195	80	2,530	1,570	2,680 J	1,930	380

A[illegible]

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

NS-3-R-AM-1	NS-3-R-AM-2	NS-3-R-AM-3	NS-3-R-AM-4	NS-3-R-AM-5	NS-3-I-AM-1	NS-3-I-AM-2	NS-3-I-AM-3	NS-3-I-AM-4	NS-3-I-AM-5	SM-3-R-AM-1	SM-3-R-AM-2	SM-3-R-AM-3	SM-3-R-AM-4	SM-3-R-AM-5
Natl Soil pH=3.0 Room Temp Flooded $\bar{X}_1$ = 6822 $\bar{X}_2$ = 772					Natl Soil pH=3.0 T=35°C $\bar{X}_1$ = 6822 $\bar{X}_2$ = 772					Manure 5 wt % pH=3.0 Room Temp Flooded $\bar{X}_1$ = 1,750 $\bar{X}_2$ = 235				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	3,000	3,380	5,050	6,870	6,810	3,600	3,780	5,050	6,870	6,810	1,330	1,210	1,980	1,830	2,040
t=30	3,540	3,630	8,750	3,420	4,810	4,300	900	570	315	[280]	2,620	6,570	1,690	4,190	3,010
t=60	245	220	685	1,520	1,080	[95]	2,454	[95]	620U	600U	365	770	485	680	720

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	1,260	490	545	445	1,130	1,260	490	545	445	1,130	305	240	240	170	220
t=30	[255]	[250]	[245]	[185]	[280]	625	405	315	890L	965	330	[165]	[240]	[270]	[185]
t=60	135	150	145	120	135	225	300	240	[140]	[175]	140	225	140	800	165

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

SMI-7-I-AM-1	SMI-7-I-AM-2	SMI-7-I-AM-3	SMI-7-I-AM-4	SMI-7-I-AM-5	IOMI-7-R-AM-1	IOMI-7-R-AM-2	IOMI-7-R-AM-3	IOMI-7-R-AM-4	IOMI-7-R-AM-5	IOMI-7-I AM-1	IOMI-7-I AM-2	IOMI-7-I AM-3	IOMI-7-I AM-4	IOMI-7-I AM-5
Manure 5 wt % pH = 7.0 T = 35°C Flooded $\bar{x}_1$ = 1,350 $\bar{x}_2$ = 235					Manure 10 wt % pH = 7.0 Room Temp Flooded $\bar{x}_1$ = 1099 $\bar{x}_2$ = 259					Manure 10 wt % pH = 7.0 T = 35°C Flooded $\bar{x}_1$ = 1099 $\bar{x}_2$ = 259				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	1,730	1,210	1,980	1,830	2,040	745	1,160	1,150	1,390	1,050	745	1,160	1,150	1,390	1,850
t=30	1,310	[250]	465	425	915	2,660	1,930	2,590	2,750	4,820	BMOL	790	BMOL	935	BMOL
t=60	[30]	665	130	1,160	[100]	1,040	854	8,730	2,110	880	450LL		540LL	540LL	710LL

	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	305	240	240	170	220	690	165	130	130	180	690	165	130	130	180
t=30	260	[215]	[180]	315	435	[160]	[232]	370	335	[165]	[260]	580	345	680	[220]
t=60	240	270	690	640	285	130	135	165	230	545	225	315	295	155	470

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

SAS-7-R-AN-1	SAS-7-R-AN-2	SAS-7-R-AN-3	SAS-7-R-AN-4	SAS-7-R-AN-5	SAS-7-I-AN-1	SAS-7-I-AN-2	SAS-7-I-AN-3	SAS-7-I-AN-4	SAS-7-I-AN-5	MAS-7-R-AN-1	MAS-7-R-AN-2	MAS-7-R-AN-3	MAS-7-R-AN-4	MAS-7-R-AN-5
Anaer. Sludge 5 wt % pH = 7.0 Room Temp Flooded k_1 = 141 k_2 = 161					Anaer. Sludge 5 wt % pH = 7.0 T = 35°C Flooded k_1 = 141 k_2 = 161					Anaer. Sludge 10 wt % pH = 7.0 Room Temp Flooded k_1 = 1483 k_2 = 412.4				

	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT	DDT
t=0	1,430	765	1,480	930	2,450	1,430	765	1,480	930	2,450	1,750	1,650	1,880	595	1,160
t=30	505	2,590	1,940	1,980	405	555	[230]	[280]	525	420	345	1,690	1,100	2,150	3,320
t=60	1,020	565	340	935	880	[185]	1,210	[75]	255	525	1,090	350	750	360	495
	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE	DDE
t=0	180	155	155	170	145	180	155	155	170	145	215	330	365	230	260
t=30	[255]	310	[245]	950	140	345	[140]	[285]	385	[160]	[177]	535	580	295	435
t=60	140	300	225	215	390	200	320	285	200	325	260	210	395	920	220

A

DDT AND DDE CONCENTRATIONS AS A FUNCTION OF TIME

MAS-7-I-AM-1	MAS-7-I-AM-2	MAS-7-I-AM-3	MAS-7-I-AM-4	MAS-7-I-AM-5
Anaer. Sludge				
10 wt %				
pH = 7.0				
T = 35°C				
Blended				
$\bar{X}_i$ = 1483				
$\bar{Y}_i$ = 412.4				

	DDT	DDT	DDT	DDT	DDT
t=0	1,750	1,650	1,880	975	1,160
t=30	410	BMDL	3,070	660	650
t=60					

	DDE	DDE	DDE	DDE	DDE
t=0	215	330	365	270	260
t=30	410	[2401]	1830	750	650
t=60					

TABLE 2
Page 1

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)*

Fungal Cells (pH=4.5)

Cell Matrix	DDT t=30	DDT t=60	DDE t=30	DDE t=60
Soil Room Temperature	0.23	~~0.053~~ 0.056 ?	0.10	~~0.12~~ 0.10
Soil T=35°C	0.25	0.27	1.67	0.77
Manure (5% by weight) Room Temperature	0.48	0.32	0.17	0.36
Manure (5% by weight) T=35°C	0.35	2.12	0.35	4.50
Manure (10% by weight) Room Temperature	0.66	0.871	0.19	0.93
Manure (10% by weight) T=35°C	1.31	5.71	1.36	7.87
Manure & Wood Chips (5% by weight) Room Temperature	0.38	0.28	0.11	0.27
Manure & Wood Chips (5% by weight) T=35°C	0.47	0.71	0.18	0.66
Manure & Wood Chips (10% by weight) Room Temperature	0.54	0.60	0.34	0.60
Manure & Wood Chips (10% by weight) T=35°C	1.06	U	1.23	U

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)

Anaerobic Cells (Flooded, pH=7)

Cell Matrix	DDT t=30	DDT t=60	DDE t=30	DDE t=60
Soil Room Temperature	0.71	0.11	0.31	0.18
Soil T=35°C	0.20	0.08	0.70	0.28
Manure (5% by weight) Room Temperature	2.06	0.34	0.98	1.25
Manure (5% by weight) T=35°C	0.33	0.24	1.62	1.81
Manure (10% by weight) Room Temperature	2.69	2.48	0.97	0.93
Manure (10% by weight) T=35°C	0.31	0.26	1.52	1.13
Anaerobic Sewage Sludge (5% by weight) Room Temperature	1.06	0.54	1.74	0.55
Anaerobic Sewage Sludge (5% by weight) T=35°C	0.28	0.28	1.59	1.65
Anaerobic Sewage Sludge (10% by weight) Room Temperature	1.16	0.40	1.43	0.95
Anaerobic Sewage Sludge (10% by weight) T=35°C	0.65	0.27	2.69	1.56

LEETOWN PESTICIDE SITE, WV
MICROBIAL DEGRADATION TREATABILITY STUDY
DEGRADATION RATIO (DR)

Aerobic Cells (pH=7)

Cell Matrix	DDT t=30	DDT t=60	DDE t=30	DDE t=60
Soil Room Temperature	0.16	0.20	0.06	0.25
Soil T=35°C	0.35	0.41	0.75	1.15
Manure (5% by weight) Room Temperature	~~0.14~~ 0.522	0.75	~~0.07~~ 0.238	0.36
Manure (5% by weight) T=35°C	~~0.68~~ 2.64	1.20	~~0.39~~ 1.29	2.06
Manure (10% by weight) Room Temperature	~~0.34~~ 2.18	2.28	~~0.15~~ 0.456	1.16
Manure (10% by weight) T=35°C	~~0.12~~ 0.716	5.81	~~0.10~~ 0.297	7.06

Notes:

* - DR=(C_{DDT} @ t = 30 days or t = 60 days)/(C_{DDT} @ t = 0)

U - results unavailable. Sample extracts inadvertently destroyed.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
CENTRAL REGIONAL LABORATORY
839 BESTGATE ROAD
ANNAPOLIS, MARYLAND 21401

301-224-2740
FTS-922-3752

DATE : November 26, 1986

SUBJECT: Leetown Pesticide Treatability Study Data

FROM : Diana Pickens (3ES23) DP
Chemist

TO : Laura Boornazian (3HW21)
Site Response Section

THRU : Patricia J. Krantz (3ES23) PK
Chief, Quality Assurance Section

As per your request, I have reviewed the data presented for t=0 to t=60 day from the Leetown Treatability Study. The information you sent plus verbal input from John Austin is the basis for this response.

The sample analysis done by NUS is a quick and dirty extraction with hexane. No cleanup of the extract is done. The identification of the pesticides is based on a one column confirmation. Although cost effective, the risks of relying on this data are:

1. Strongly sorbed compounds may not be detected. DDT and metabolites are likely to fall into this category. The reported results may be low estimates of the actual concentration present.

2. Lack of extract cleanup allows interferences from naturally occurring organic matter to interfere with both identification and quantitation of the target compounds.

3. Lack of standardized analytical protocol used in the mobile lab may introduce extraneous variability into the data set.

The analyses which will be performed by CRL as a lab split may provide some information to support the original feasibility design. CRL will utilize an exhaustive soxhlet extraction protocol and any necessary cleanups. The reported values will contain an estimate of even highly-sorbed constituents without counting extraneous organic matter as DDT or metabolites. If necessary, confirmation of the presence of interferences after routine cleanups may be obtained using an ion chromatograph at CRL. Since the data from the NUS-CRL lab split will be obtained through entirely different protocols, their results may not agree. Keep in mind that the data will be useful to determine which modifications (if any), are appropriate for future analytical work for this study.

In addition to analytical comments, I offer the following feedback. It is very difficult to see trends in the data using a table of "degredation ratios". Page 4-9 discusses use of ANOVA. I strongly recommend presenting the data using ANOVA. It is entirely possible (and likely) that the values which appear to be "creating" DDT and/or DDE are actually values containing false positives due to the organic matter in the samples. I do not agree with the proposal to ignore these study cells based on the information presented.

I recommend two action items to help define the quality of data in the presented tables:

1. Description of actual methodology and routine QC performed in the mobile lab; and
2. ANOVA results in tabular form.

These two pieces in addition to the results of the lab split will be very beneficial in overall interpretation of the treatability data. It may be appropriate to request ESD assistance in interpretation once all the additional information is combined.

cc: John Austin (3ES21)
Rosemary Kayser
Deb Scheib , NUS Pittsburgh

DP:wbg

NUS CORPORATION
PARK WEST TWO
CLIFF MINE ROAD
PITTSBURGH, PENNSYLVANIA 15275-1071
(412) 788-1080

December 10, 1986
NUSP/86-0293
NA

Ms. Laura Boornazian (3HW21)
U.S. Environmental Protection Agency
Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

Subject: REM III PROGRAM - EPA CONTRACT NO. 68-01-7250
SUMMARY OF REVISIONS TO MICROBIAL INVESTIGATION
TREATABILITY STUDY FROM FINAL WORK PLAN (JUNE 1986)

Dear Laura:

Enclosed please find copies of the three Leetown Pesticide Site Treatability Study progress reports submitted to date. These enclosures outline, in detail, the work accomplished with the exception of the most recent round of sampling and analysis. The attached progress reports present information relative to the following sampling rounds:

- Progress Report No. 1 - One hundred and thirty (130) reaction vessels were generated from June 25 through 29, 1986. Baseline (t=0) samples were collected and analyzed.

- Progress Report No. 2 - One hundred and thirty (130) reaction vessels were sampled and DDT/DDE analysis was performed during the week of July 28, 1986.

- Progress Report No. 3 - One hundred and thirty (130) reaction vessels were sampled and DDT/DDE analysis was performed during the period of September 5 through September 18, 1986.

During the most recent (fourth) sampling round, only four sets of five cells were sampled, as per our discussion. Five samples were obtained from each of the following sets of cells (5 cells per set):

- Natural soil, pH=7.0, room temperature, aerobic conditions.
- Natural soil, pH=4.5, room temperature, aerobic conditions.
- Natural soil, pH=7.0, room temperature, anaerobic conditions.
- Natural soil, pH=7.0, T=35^{o}C, anaerobic conditions.

Analysis of these samples has been completed. Once the data have been compiled, an evaluation will be performed, including a complete analysis of variance (ANOVA), and a progress report will be submitted.

Twelve (12) samples were shipped to the EPA Central Regional Laboratory (CRL) in Annapolis on December 9, 1986 for confirmatory analysis. Ten samples were submitted for pesticide analysis only. Two samples were submitted for full Superfund Hazardous Substances List analysis as per your request.

One hundred samples were collected and analyzed during the most recent sampling round, so that 12% of the samples were submitted for confirmation. A copy of the NUS field screening extraction and analytical protocol was sent to the EPA CRL with the samples. I have enclosed two copies of the protocol for your information.

As per your request I have reviewed the Scope of Work outlined in the Work Plan for the Leetown Pesticide Site Treatability Study. In addition to the fourth sampling round, which was not included in the original scope of work, the following deviations are noted:

- The original period of performance was to have been from late June through mid-September, constrained by the close of the contract period on September 30, 1986. Sampling was originally to have been done at periods of approximately 30 days, with three rounds completed by mid-September. With the concurrence of Mr. Ed Schoener of your office we agreed to update the progress of the work with technical memoranda following the conclusion of analysis and quantitation of the results of each of the sampling tasks. The artificial constraint of the end of the REM/FIT contract was removed with the understanding that the work would proceed beyond September, under the present REM III contract.

- Two sets of cells consisting of an aerobic sludge/soil mixture were not configured at the outset of the study. A suitable aerobic sludge could not be obtained. Two sludges were obtained from local sewage treatment plants but both were essentially aqueous. An attempt to filter solids from these aqueous solutions was unsuccessful. Based on the fact that there is no evidence indicating that aerobic microorganisms are capable of degrading 4,4'-DDE and because a suitable sludge could not be obtained, a decision was made to delete these cells from the study.

- As per the request of Dr. Richard Brunker of your office, cells were configured for a photolytic degradation study. These cells consisted of ultraviolet-transmissive plastic containers. These cells were placed in

an area where they would receive as much sunlight as possible (i.e., on a roof area with a southern exposure). Unfortunately, these cells were destroyed during a wind storm several months ago. Only baseline samples had been collected from these cells prior to the storm.

Please contact Mr. John George or myself if you have any comments or questions.

Very truly yours,

Robert J. Hubbard

Robert J. Hubbard

RJH/cts
Enclosures
cc: L. J. Apoldo (Ebasco) w/encl.
File: Leetown 106-3L52
Daily

C-34-12-6-387

TO: FILE

DATE: DECEMBER 30, 1986

FROM: ROBERT J. HUBBARD RJH

COPIES: A. BOMBERGER
D. BRENNEMAN
D. MACINTYRE
H. ROFFMAN
J. GEORGE

SUBJECT: LEETOWN PESTICIDE SITE
TREATABILITY STUDY
PROGRESS REPORT #4
EPA WORK ASSIGNMENT NO. 106-3L52
NUS PROJECT NO. 372Y.01

A fourth round of samples was obtained from the Leetown Pesticide Site Treatability Study cells during the period ranging from November 25 through December 2, 1986. Samples were analyzed using gas chromatography equipment housed in a mobile laboratory rented from the NUS office in Lansing, Michigan during the period from December 2 through December 8, 1986. Samples were refrigerated during the period between sampling and analysis.

As outlined in Progress Report No. 3 (dated September 29, 1986; NUS Correspondence No. C-34-9-6-43), four sets of five cells each were selected for sampling and analysis during the fourth sampling round. The decision to sample only four of the thirteen total cell configurations was based on the fact that the selected cells had exhibited the most promising results during the second and third sampling rounds. Some deviation to the original scope of work was made in this respect. As outlined in the original work plan, it was intended that all cells be sampled three times during the course of the Treatability Study. In view of the promising results obtained for the selected cells and as a result of the desire to collect numerous samples for statistical analysis, 100 samples were obtained, rather than 130. In the past only one sample had been obtained from each of the five separate cells constituting each cell configuration. During the most recent sampling round, a total of five samples were collected from each of the selected cells. Thus, 25 samples of each of the selected cell configurations were obtained. Split samples were collected from some cells and submitted to the EPA laboratory in Annapolis for confirmation analysis. The quantity of soil remaining in the cells sampled during the fourth round may introduce some limitations on the amount of sampling that can be conducted in the future.

The cell configurations selected for sampling and analysis were as follows:

Cell Configuration	Matrix	pH	Temperature	Oxygen Conditions
NS-7-R-AN	Natural Soil	7.0	20°C	Anaerobic
NS-7-I-AN	Natural Soil	7.0	35°C	Anaerobic
NS-4-R-A	Natural Soil	4.5	20°C	Aerobic
NS-7-R-A	Natural Soil	7.0	20°C	Aerobic

The analytical results for each of the 25 samples from each of the above cell configurations are included in the attached statistical summaries. The results were subjected to Analysis of Variance (ANOVA) to determine if 1) there is any statistically significant difference between the various samples

collected from each of the individual treatment cells comprising each cell configuration (i.e., does the overall average for these samples provide a representative population mean), and 2) is there a significant difference in DDT and DDE concentrations from one cell configuration (i.e., treatment) to the next. To meet these objectives, ANOVA was first performed using the 5 sets of 5 sample results for each individual treatment cell. Matrices with dimensions of 5 x 5 were generated. The results of the statistical analysis conducted in this manner are presented on pages 3 through 8 of the attached computer printouts. A summary of the statistical analysis for this application is provided in Table 1. An example of one of the statistical printouts has been included with the attachment, with hand-written notes to clarify the information presented.

The results obtained from the aforementioned statistical analyses were then employed to contrast the variations between the individual cell configurations. The average values calculated from the five samples from each individual cell in a given configuration were entered as representative concentrations for that cell. A matrix of dimensions 4 x 5 was generated and subjected to ANOVA, as shown on pages 1 and 2 of the attached printouts. The results of the statistical comparison for the various cell configurations are provided in Table 2.

It should be noted that during previous sampling rounds it had become evident that matrix effects (i.e., heterogeneity in the sample cells) had resulted in highly variable results between each of the 5 cells comprising each configuration. In view of this difficulty, Ms. Laura Boornazian, the EPA Regional Project Manager (RPM) at EPA Region III, suggested that a different sampling approach be used during the fourth sampling round. Ms. Boornazian suggested that approximately one third of the remaining soil in each cell be removed and thoroughly mixed prior to analysis. This recommendation was implemented, and the results obtained for samples obtained in this manner are more consistent from one cell to the next. It is apparent that replicate samples taken from the same cell result in a more accurate average value for a given cell. No statistical statement can be made regarding the accuracy of results obtained during the second and third sampling rounds because only one sample was obtained from each cell. The results of the most recent sampling round and the implications of these results are discussed in more detail below.

Table 1 summarizes the statistical results for each of the four cell configurations sampled and analyzed during the fourth round. The average concentrations, standard deviations from the average concentration, average degradation ratio (i.e., the average of the concentrations from the fourth round divided by the baseline soil concentration), the standard deviation of the degradation ratios from their population mean, and the F ratio calculated using ANOVA are presented in the table. Literature values of F values are also included on the table for comparative purposes.

As can be seen from the tabulated values, virtually all of the F values fall below the literature value provided for the 0.01 level of significance. This indicates that the results for the five sets of five samples for each cell configuration do not differ significantly from one set to the next. Hence the average concentration calculated for each cell configuration is representative of the population mean. Virtually the only cell in which a significant difference in the variance between cells versus the variance within cells was noted was in the DDE results for cell configuration NS-7-R-A. This indicates that there is a significant difference (at the 0.001 level) between the average concentrations for each set of 5 samples. It is apparent that some variance was introduced during generation of these cells.

As shown on Table 2 there is a statistically significant difference between the various cell configurations. The F Ratios calculated using the average values for all 25 cells in each configuration are in excess of 10.0 for both DDT and DDE. This implies that there is only a 0.1% probability that the null hypothesis (i.e., the various cell configurations are from populations with the same mean) is true for the different cell configurations.

The statistical results appear consistent with the expected results. The fact that the individual results for a given cell configuration were generally consistent validates the sample collection and analytical protocols. In addition, it was anticipated that significant differences between various cell configurations would be obtained. Once again, this is evident from the statistical analysis.

It is apparent from review of the fourth round concentrations and degradation ratios that certain cell configurations display more promising results than others.

- DDT degradation appears to be most prounounced under anaerobic conditions at 35^{o}C.

- DDE degradation appears to be most pronounced under aerobic conditions, at room temperature, in the acidic cells.

These results are generally consistent with the anticipated results. The degradation of DDT under anaerobic conditions is documented in the literature, whereas the acidic cells were included in the study in an attempt to induce fungal degradation of the DDE.

Table 3 presents a summary of degradation rate constants calculated using the baseline soil concentrations. Two values are presented, one based on the assumption that degradation obeys zeroth order kinetics (i.e., a linear relationship), and one based on the assumption that degradation obeys first order kinetics (i.e., a logarithmic relationship). The intermediate results for these cells (i.e., those obtained during the second and third sampling rounds) have not been included in the calculation of these rate constants because of their questionable accuracy, as previously discussed. The expressions used to determine the rate constants are as follows:

0th Order Kinetics: $k = (C_0 - C_4)/t$ (linear)

1st Order Kinetics: $k = \ln(C_0/C_4)/t$ (logarithmic)

The 0th order rate constant is derived based on the assumption that the degradation of DDT and DDE are independent of both the substrate (contaminant) concentration and the concentration of the enzymes (a function of the microbial population). The 1st order rate constant is derived based on the assumption that the degradation rate is contingent only upon the concentrations of DDT and DDE. Although it is likely that the rate constant depends on both the substrate and enzyme concentrations (e.g., Michaelis-Menton kinetics), no basis for identifying the enzyme or quantifying their concentrations is available.

Inspection of the rate constants (for a given analyte) presented in Table 3 indicates that they are remarkably similar from one cell configuration to the next. Thus, it appears that there may be some phenomenon causing depletion of the contaminant concentrations other than microbial degradation. Of all the potential explanations for such a phenomenon, evaporative losses are considered the most plausible. Although the vapor pressures of DDT and DDE are low, there can be no doubt that some losses because of evaporation have occurred. Note, however, that evaporation should be greater in those cells that are open to the atmosphere than in those that are sealed (i.e., the anaerobic vessels). The analytical results do not indicate that there is a substantial difference between the anaerobic cells versus the aerobic cells. Thus, while evaporative losses are considered possible, there is not overwhelming evidence of this in the analytical results.

As a result of the review of the most recent round of sampling data it is felt that the anaerobic vessels operating under incubated conditions represents the best method of degrading DDT. The DDT and DDE in these cells are less subject to evaporation, yet there has apparently been substantial degradation of both contaminants. Although the degradation of DDE in these cells is not as pronounced as in the other cells, it is apparent that some degradation of DDE has occurred. Although the initial literature review indicated that degradation of DDE does not occur under anaerobic conditions, it is apparent that degradation of DDE by microorganisms indigenous to the contaminated Leetown soil may be induced.

The treatability study thus far has indicated that both DDT and DDE degradation may be effected under anaerobic conditions. Robinson property pesticide action levels (i.e., accepted pesticide residuals in soil following treatment) have been established in the Record of Decision (ROD) and are noted below:

- Former Pesticide Pile Area - Total DDT and metabolites = 300 ug/kg.
- Former Pesticide Mixing Area - Total DDT and metabolites = 1200 ug/kg.

Establishment of anaerobic, adiabatic treatment cells may be the most effective means of reaching the desired action levels for DDT and its metabolites. At the present time, the best degradation of both analytes has occurred in the incubated, anaerobic vessel. The average total concentration of DDT and DDE remaining in the incubated, anaerobic vessel after approximately 160 days is about 820 ug/kg, based on NUS-analytical results. Hopefully the results for the most recent round of sampling will be confirmed in split samples submitted to the EPA Annapolis laboratory. These results have not been received to date.

If the 1st order rate constants presented in Table 3 apply to the microbial degradation of DDT and DDE, and if it is assumed that the composited soil from the pesticide pile area at Leetown will be roughly similar to the baseline concentrations of the soil composited from the Robinson property (i.e., approximately 7000 ug/kg DDT and 1000 ug/kg DDE) the length of time required to reach the desired action levels may be estimated using the following expression:

$$DDT(t) + DDE(t) = \text{Action Level} =$$

$$7000 \text{ ug/kg } \exp(-1.5\times10^{-2}t) + 1000 \text{ ug/kg } \exp(-8.8\times10^{-3}t) = 300 \text{ ug/kg}$$

This expression does not lend itself to a closed-form solution for time (t), but trial and error can be used to determine that approximately 8 months (i.e., between 240 and 245 days) will be required to reach the desired action level. The assumption of a baseline concentration of approximately 8,000 ug/kg may be lower than the actual concentration since the analytical protocol is biased towards achieving better results at low concentrations. Previous analytical results for split samples submitted to the Annapolis lab indicate that the NUS field screening protocols may underestimate concentrations if analytes are present at high levels. Thus, the operating period required to achieve the specified action levels may be greater than that derived above.

At this point, EPA Region III will be consulted regarding the applicability of the adiabatic, anaerobic treatment configuration, for pilot scale study. Additional study of this cell configuration, including further sampling and analysis of the cells and commencement of the carbon-14 study (using at least this configuration) may be warranted. Additional sampling of the incubated, anaerobic cells will confirm or negate the results of the fourth sampling round. Adequate material (soil) remains for one full laboratory analysis. If several months are allowed to pass before additional samples are collected, it may be possible to demonstrate that the desired action level has been achieved or is being approached. In addition, some study of the toxicity of the metabolites present in the incubated, anaerobic vessel is probably warranted (i.e., an Ames toxicity test) to demonstrate that the metabolites are less toxic than the parent compounds. It may be possible to identify some of the metabolites through Thin Layer Chromotography (TLC) or Gas Chromotogrpahy/Mass Spectrometry (GC/MS).

At this point in the treatability study it is felt that the primary issue relative to the efficacy of the microbial degradation scheme is the toxicity and environmental mobility of the metabolites present in the incubated, anaerobic vessels. Before any additional study of degradation (e.g., the carbon-14 study) is undertaken, some effort should be made to ensure that the treatment scheme results in generation of non-toxic (or less toxic, immobile) species of chlorinated hydrocarbons. If it can be demonstrated that the metabolites are not hazardous, further study of the degradation rates at the bench scale will provide the information necessary to devise the pilot scale study.

TABLE 1
ANOVA BETWEEN CELLS WITHIN EACH CONFIGURATION
TREATABILITY STUDY
LEETOWN PESTICIDE SITE
FOURTH SAMPLING ROUND

CELL	AVERAGE CONCEN.	STANDARD DEVIATION	AVERAGE DEGRAD.	STANDARD DEVIATION	F RATIO
DDT:					
NS-7-R-AN	2600	1100	0.38	0.16	3.6
NS-7-I-AN	630	660	0.092	0.097	1.7
NS-7-R-A	2200	750	0.33	0.11	2.4
NS-4-R-A	2100	920	0.31	0.13	1.9
DDE:					
NS-7-R-AN	84	37	0.11	0.048	0.19
NS-7-I-AN	190	100	0.24	0.13	0.65
NS-7-R-A	91	47	0.12	0.061	11
NS-4-R-A	71	29	0.092	0.037	0.59

F VALUES

LEVEL OF SIGNIFICANCE	F VALUE
0.100	2.25
0.050	2.87
0.025	3.29
0.010	4.43
0.005	5.17
0.001	7.10

NOTES:

1. All concentrations presented in ug/kg (parts per billion).
2. Average degradation based on average of 25 samples divided by baseline soil concentrations (DDT = 6822 ug/kg; DDE = 772 ug/kg).
3. Standard deviation determined using average concentations for all 25 cells.
4. F Values presented are for (k-1) = (5-1) = 4 vertical degrees of freedom, and k(n-1) = 5(5-1) = 20 horizontal degrees of freedom.
5. Source of F values - Standard Mathematical Tables, 22nd Ed., CRC Press, Boca Raton, Florida, 1974.

TABLE 2
ANOVA BETWEEN CELL CONFIGURATIONS
TREATABILITY STUDY
LEETOWN PESTICIDE SITE
FOURTH SAMPLING ROUND

CELL	AVERAGE CONCEN.	STANDARD DEVIATION	AVERAGE DEGRAD.	STANDARD DEVIATION	F RATIO
DDT:	1900	560	0.28	0.082	12
DDE:	110	29	0.14	0.038	17

F VALUES

LEVEL OF SIGNIFICANCE	F VALUE
0.005	6.30
0.001	9.00

NOTES:

1. All concentrations presented in ug/kg (parts per billion).
2. Average degradation based on average of 100 sample concentrations divided by baseline soil concentrations (DDT = 6822 ug/kg; DDE = 772 ug/kg).
3. Standard deviation derived as square root of average of variances for 4 different cell configurations (25 samples per cell configuration). See attached printouts for statistical summaries.
4. F Values presented are for (k-1) = (4-1) = 3 vertical degrees of freedom, and k(n-1) = 4(5-1) = 16 horizontal degrees of freedom.
5. Source of F values - Standard Mathematical Tables, 22nd Ed., CRC Press, Boca Raton, Florida, 1974.

TABLE 3
DEGRADATION RATE CONSTANTS
TREATABILITY STUDY
LEETOWN PESTICIDE SITE
FOURTH SAMPLING ROUND

ANALYTE	CELL	k (Rate Constant) 0TH ORDER (ug/kg/day)	1ST ORDER (day^{-1})
DDT:	NS-7-R-AN	26	6.0×10^{-3}
	NS-7-I-AN	39	1.5×10^{-2}
	NS-7-R-A	29	7.0×10^{-3}
	NS-4-R-A	30	7.4×10^{-3}
DDE:	NS-7-R-AN	4.3	1.4×10^{-2}
	NS-7-I-AN	3.6	8.8×10^{-3}
	NS-7-R-A	4.3	1.5×10^{-2}
	NS-4-R-A	4.4	8.8×10^{-2}

NOTES:

1. Rate constants derived using t = 160 days.
2. Results presented to two significant figures.

SAMPLE CALCULATIONS:

1. 0th order kinetics, DDT, NS-7-R-AN:

   k = (6,822 ug/kg - 2,603 ug/kg)/160 days = 26 ug/kg/day

2. 1st order kinetics, DDT, NS-7-R-AN:

   $k = \ln((6{,}822 \text{ ug/kg})/(2{,}603 \text{ ug/kg}))/160 \text{ days} = 6.0 \times 10^{-3} \text{ days}^{-1}$

Number of samples/cell — Number of cells — Analyte — Cell Configuration

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT
I=	5	CELL:	NS-7-R-AN

Cell No. — Sample No. — Concentration

	1	2	3	4	5
1	2045	3330	5125	3410	3000
2	2515	2880	1955	3020	715
3	1090	1670	4345	2470	800
4	1350	1780	3405	2370	2330
5	1815	4240	3405	3525	2300
COL AVERAGE	1763	2780	3647	2959	1869
SIGMA1 SQ	317807.5	1169050	1412910	278330	1071080
SIGMA1 SQ AVG	853847.5	} Variance within samples.			
OVERALL AVG	2603.6				
SIGMA2 SQ 1	2492355.	} Intermediate calculations*			
SIGMA2 SQ 2	33893665				
SIGMA2 SQ 3	3115444	} Variance between samples.			

F RATIO: 3.648711

ANALYSIS OF VARIANCE SPREADSHEET
** DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT	6300 — Baseline Concentration
I=	5	CELL:	NS-7-R-AN	

Degradation Ratio.

	1	2	3	4	5
1	.2997655	.4831166	.7512460	.4985534	.4397533
2	.3656632	.4111636	.2615729	.4426854	.1048060
3	.1597771	.2447961	.6369100	.3626639	.1171677
4	.1978391	.2699206	.4991205	.3474055	.3415421
5	.2660510	.6215186	.4991165	.5167106	.3664614
COL AVERAGE	.2584256	.4175151	.5345941	.4337438	.2777666
SIGMA1 SQ	.0068237	.0251194	.0313595	.0159816	.0234441
SIGMA1 SQ AVG	.0183467				
OVERALL AVG	.3816476				
SIGMA2 SQ 1	.0535533				
SIGMA2 SQ 2	.7282745				
SIGMA2 SQ 3	.0669417				

F RATIO: 3.648711

* SIGMA2 SQ2 IS A RESIDUAL FROM ORIGINAL 5X10 MATRIX. IS NOT USED IN THE CALCULATIONS. NOTE THAT F RATIO FOR DEGRATION RATIOS DUPLICATES THAT FOR CONCENTRATIONS (CROSS-CHECK)

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY S

N=	5	CHEMICAL:	DDT
K=	4	CELL:	ALL CELLS

	1	2	3	4
1	1763	2105	2857	1074
2	2780	2972	1608	111
3	3647	2020	2441	586
4	2959	1754	2018	536
5	1869	1631	2170	838
COL AVERAGE	2603.6	2096.4	2218.8	629
SIGMA1 SQ	623088.8	276605.3	218112.7	130132
SIGMA1 SQ AVG	311984.7			
OVERALL AVG	1886.95			
SIGMA2 SQ 1	2250019.			
SIGMA2 SQ 2	1780290			
SIGMA2 SQ 3	3750031.			

F RATIO: 12.01992

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILI

N=	5	CHEMICAL:	DDT
K=	4	CELL:	ALL CELLS

	1	2	3	4
1	.2584286	.3085605	.4187921	.1574318
2	.4075051	.4356494	.2357080	.0162709
3	.5345940	.2961009	.3578130	.0858986
4	.4337438	.2571094	.2958077	.0785693
5	.2739666	.2390794	.3180885	.1228379
COL AVERAGE	.3816476	.3072999	.3252419	.0922017
SIGMA1 SQ	.0133883	.0059434	.0046866	.0027962
SIGMA1 SQ AVG	.0067036			
OVERALL AVG	.2765978			
SIGMA2 SQ 1	.0483662			
SIGMA2 SQ 2	.3825316			
SIGMA2 SQ 3	.0805771			

F RATIO: 12.01992

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY S

N=	5	CHEMICAL:	DDE	
M=	4	CELL:		ALL CELLS

	1	2	3	4
1	77	72	156	133
2	84	71	60	205
3	76	60	110	189
4	90	87	65	235
5	93.6	65	61	178.4
COL AVERAGE	84.12	71	90.8	188.08
SIGMA1 SQ	60.272	103.5	1846.7	1404.032

SIGMA1 SQ AVG 853.626
OVERALL AVG 108.5
SIGMA2 SQ 1 8646.901
SIGMA2 SQ 2 58861.25
SIGMA2 SQ 3 14411.50

F RATIO: 16.88269

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILI

N=	5	CHEMICAL:	DDE	
M=	4	CELL:		ALL CELLS

	1	2	3	4
1	.0997409	.0932643	.2046631	.1712796
2	.1088083	.0919689	.0777202	.2655440
3	.0984456	.0777202	.1424870	.2448187
4	.1165803	.1126943	.0841969	.3044041
5	.1212435	.0841969	.0790155	.2310881
COL AVERAGE	.1089637	.0919689	.1176166	.2436269
SIGMA1 SQ	.0001011	.0001737	.0030986	.0023558

SIGMA1 SQ AVG .0014333
OVERALL AVG .1405440
SIGMA2 SQ 1 .0145086
SIGMA2 SQ 2 .0987631
SIGMA2 SQ 3 .0241810

F RATIO: 16.88269

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			
P =	5	CELL:	NS-7-R-AN			
		1	2	3	4	5
	1	2045	3330	5125	3410	3000
	2	2515	2880	1955	3020	715
	3	1090	1670	4345	2470	800
	4	1350	1780	3405	2370	2330
	5	1815	4240	3405	3525	2500
COL AVERAGE		1763	2780	3647	2959	1889
SIGMA1 SQ		317807.5	1169050	1412920	278380	1091080
SIGMA1 SQ AVG		853847.5				
OVERALL AVG		2603.6				
SIGMA2 SQ 1		2492356.				
SIGMA2 SQ 2		3389365				
SIGMA2 SQ 3		315444				

F RATIO: 3.648712

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			6822
P =	5	CELL:	NS-7-R-AN			
		1	2	3	4	5
	1	.2997655	.4881266	.7512460	.4998534	.4397537
	2	.3686602	.4221636	.2865729	.4426854	.1048080
	3	.1597772	.2447961	.6369100	.3620639	.1722677
	4	.1978892	.2609206	.4991205	.3474055	.3415421
	5	.2660510	.6215186	.4991205	.5167106	.3664614
COL AVERAGE		.2584286	.4075051	.5345940	.4337438	.2759666
SIGMA1 SQ		.0068287	.0251194	.0303595	.0059816	.0234441
SIGMA1 SQ AVG		.0183467				
OVERALL AVG		.3816476				
SIGMA2 SQ 1		.0535533				
SIGMA2 SQ 2		.7282745				
SIGMA2 SQ 3		.0669417				

F RATIO: 3.648712

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			
P =	5	CELL:	NS-7-R-AN			
		1	2	3	4	5
	1	60	85	80	65	95
	2	120	100	45	65	30
	3	110	60	100	95	45
	4	50	65	85	140	205
	5	45	110	70	85	90
COL AVERAGE		77	84	76	90	93.6
SIGMA1 SQ		1245	467.5	417.5	950	4712.3
SIGMA1 SQ AVG		1558.46				
OVERALL AVG		84.12				
SIGMA2 SQ 1		241.066				
SIGMA2 SQ 2		35380.87				
SIGMA2 SQ 3		301.36				

F RATIO: .193704

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			772
P =	5	CELL:	NS-7-R-AN			
		1	2	3	4	5
	1	.0777202	.1101036	.1036269	.0841969	.1269430
	2	.1554404	.1295337	.0582902	.0841969	.0388601
	3	.1424870	.0777202	.1295337	.1230570	.0582902
	4	.0647668	.0841969	.1101036	.1813472	.2655440
	5	.0582902	.1424870	.0906736	.1101036	.1165803
COL AVERAGE		.0997409	.1088083	.0984456	.1165803	.1212435
SIGMA1 SQ		.0020870	.0007844	.0007005	.0015940	.0079068
SIGMA1 SQ AVG		.0026148				
OVERALL AVG		.1089637				
SIGMA2 SQ 1		.0004045				
SIGMA2 SQ 2		.0593655				
SIGMA2 SQ 3		.0005057				

F RATIO: .193704

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			
I =	5	CELL:	NS-4-R-A			
		1	2	3	4	5
	1	1735	2115	3255	1410	1435
	2	2495	3640	685	2505	3760
	3	1950	3045	1960	985	970
	4	1590	2750	2155	945	1030
	5	2755	3310	2045	2805	960
COL AVERAGE		2105	2972	2020	1754	1631
SIGMA1 SQ		250187.5	337382.5	832475	814055	1454855
SIGMA1 SQ AVG		737791				
OVERALL AVG		2096.4				
SIGMA2 SQ 1		110642.				
SIGMA2 SQ 2		2974465				
SIGMA2 SQ 3		1383027.				

F RATIO: 1.874551

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			6822
I =	5	CELL:	NS-4-R-A			
		1	2	3	4	5
	1	.2543242	.3100264	.4771328	.2066842	.2103489
	2	.3657285	.5335679	.1004104	.3759894	.5511580
	3	.2858399	.4463500	.2873058	.1443656	.1421870
	4	.2330695	.4031076	.3158898	.1385214	.1509321
	5	.4038405	.4851950	.2997650	.4199648	.1407112
COL AVERAGE		.3085605	.4356494	.2961009	.2571094	.2390794
SIGMA1 SQ		.0053758	.0072494	.0178874	.0174916	.0312605
SIGMA1 SQ AVG		.0158529				
OVERALL AVG		.3072999				
SIGMA2 SQ 1		.0237737				
SIGMA2 SQ 2		.4721662				
SIGMA2 SQ 3		.0297171				

F RATIO: 1.874551

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			
K=	5	CELL:	NS-4-R-A			
		1	2	3	4	5
	1	50	70	40	45	55
	2	75	85	40	120	55
	3	95	60	30	55	40
	4	75	70	90	60	65
	5	65	70	100	155	110
COL AVERAGE		72	71	60	87	65
SIGMA1 SQ		270	80	1050	2307.5	712.5
SIGMA1 SQ AVG		884				
OVERALL AVG		71				
SIGMA2 SQ 1		414				
SIGMA2 SQ 2		25205				
SIGMA2 SQ 3		517.5				

F RATIO: .5854072

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			712
K=	5	CELL:	NS-4-R-A			
		1	2	3	4	5
	1	.0641768	.0906736	.0518135	.0582902	.0712435
	2	.0971503	.1101036	.0518135	.1554404	.0712435
	3	.1230570	.0777202	.0388601	.0712435	.0518135
	4	.0971503	.0906736	.1165803	.0777202	.0841969
	5	.0841969	.0906736	.1295337	.2007771	.1424870
COL AVERAGE		.0932642	.0919689	.0777202	.1120943	.0841969
SIGMA1 SQ		.0004530	.0001342	.0017618	.0038717	.0011955
SIGMA1 SQ AVG		.0014833				
OVERALL AVG		.0919689				
SIGMA2 SQ 1		.0006946				
SIGMA2 SQ 2		.0422914				
SIGMA2 SQ 3		.0008683				

F RATIO: .5854072

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			
P=	5	CELL:	NS-7-R-A			
		1	2	3	4	5
	1	3105	1400	3485	2940	1505
	2	2710	1395	1570	2450	1645
	3	3065	1545	1905	1090	2265
	4	2265	1845	2920	2785	3355
	5	3040	1855	2325	825	2080
COL AVERAGE		2845	1608	2441	2018	1170
SIGMA1 SQ		141482.5	52445	594692.5	977357.5	534800
SIGMA1 SQ AVG		4e0357.5				
OVERALL AVG		2218.8				
SIGMA2 SQ 1		872450.8				
SIGMA2 SQ 2		2461567				
SIGMA2 SQ 3		10905e4.				

F RATIO: 2.368959

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			6821
P=	5	CELL:	NS-7-R-A			
		1	2	3	4	5
	1	.4e9803e	.2052184	.5108477	.4309587	.2106098
	2	.3972442	.2044855	.2301378	.3591322	.2411316
	3	.4492817	.2264732	.2792436	.1597772	.3230141
	4	.3320141	.2704485	.4280270	.4082381	.4917913
	5	.4456171	.2719144	.3408091	.1206322	.3048959
COL AVERAGE		.4187911	.2357080	.3578130	.2956077	.3160685
SIGMA1 SQ		.0030e15	.0011267	.0127782	.0210005	.0114913
SIGMA1 SQ AVG		.0096917				
OVERALL AVG		.3252419				
SIGMA2 SQ 1		.01874e4				
SIGMA2 SQ 2		.5289114				
SIGMA2 SQ 3		.0234330				

F RATIO: 2.368959

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			
I =	5	CELL:	NS-7-R-A			
		1	2	3	4	5
	1	215	60	150	80	50
	2	85	50	125	40	55
	3	180	70	85	65	45
	4	170	75	95	95	70
	5	140	45	95	45	85
COL AVERAGE		158	60	110	65	61
SIGMA1 SQ		2382.5	162.5	725	537.5	267.5
SIGMA1 SQ AVG		815				
OVERALL AVG		90.8				
SIGMA2 SQ 1		7386.8				
SIGMA2 SQ 2		41223.2				
SIGMA2 SQ 3		9233.5				

F RATIO: 11.32945

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			TI
I =	5	CELL:	NS-7-R-A			
		1	2	3	4	5
	1	.2784974	.0777202	.1943005	.1036269	.0647668
	2	.1101036	.0647668	.1619171	.0518135	.0712435
	3	.2331606	.0906736	.1101036	.0841969	.0582902
	4	.2202073	.0971503	.1230570	.1230570	.0906736
	5	.1813472	.0582902	.1230570	.0582902	.1101036
COL AVERAGE		.2046631	.0777202	.1424870	.0841969	.0790155
SIGMA1 SQ		.0039976	.0001727	.0011165	.0009019	.0004488
SIGMA1 SQ AVG		.0013675				
OVERALL AVG		.1176166				
SIGMA2 SQ 1		.0123943				
SIGMA2 SQ 2		.0691683				
SIGMA2 SQ 3		.0154929				

F RATIO: 11.32945

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			
M =	5	CELL:	NS-7-I-AN			
		1	2	3	4	5
	1	360	135	385	885	1465
	2	0	105	990	360	1015
	3	2315	155	75	250	480
	4	2550	160	1015	645	440
	5	145	0	465	540	790
COL AVERAGE		1074	111	586	536	838
SIGMA1 SQ		1561243.	4317.5	165855	61617.5	178332.5
SIGMA1 SQ AVG		394273				
OVERALL AVG		629				
SIGMA2 SQ 1		520528				
SIGMA2 SQ 2		1978205				
SIGMA2 SQ 3		650660				

F RATIO: 1.650176

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDT			6822
M =	5	CELL:	NS-7-I-AN			
		1	2	3	4	5
	1	.0527704	.0197889	.0564351	.1297274	.1474664
	2	0	.0153914	.1451187	.0527704	.1487833
	3	.3393433	.0172206	.0109938	.0366461	.0703606
	4	.3737907	.0134533	.1487833	.0945471	.0644972
	5	.0212546	0	.0685618	.0791557	.1158018
COL AVERAGE		.1574318	.0163709	.0858966	.0785693	.1226379
SIGMA1 SQ		.0335465	.0000928	.0035637	.0013240	.0026318
SIGMA1 SQ AVG		.0084718				
OVERALL AVG		.0922017				
SIGMA2 SQ 1		.0111846				
SIGMA2 SQ 2		.0425058				
SIGMA2 SQ 3		.0139808				

F RATIO: 1.650278

ANALYSIS OF VARIANCE SPREADSHEET
CONCENTRATIONS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			
P=	5	CELL:	NB-7-I-AN			
		1	2	3	4	5
	1	75	175	125	250	50
	2	50	420	215	135	182
	3	70	70	220	200	165
	4	165	200	230	260	95
	5	305	160	155	330	400
COL AVERAGE		133	205	189	235	178.4
SIGMA1 SQ		11207.5	16850	2142.5	5275	18185.3
SIGMA1 SQ AVG		10732.06				
OVERALL AVG		188.08				
SIGMA2 SQ 1		5616.126				
SIGMA2 SQ 2		176875.4				
SIGMA2 SQ 3		7010.16				

F RATIO: .6541198

ANALYSIS OF VARIANCE SPREADSHEET
DEGRADATION RATIOS - LEETOWN PESTICIDE SITE TREATABILITY STUDY

N=	5	CHEMICAL:	DDE			772
P=	5	CELL:	NB-7-I-AN			
		1	2	3	4	5
	1	.0971503	.2166839	.1519171	.3238342	.0647668
	2	.0647668	.5440415	.2784974	.1748705	.2357513
	3	.0906336	.0906736	.2849741	.2590674	.2137306
	4	.2137306	.2590674	.2979275	.3367876	.1230579
	5	.3950777	.2071539	.2007771	.4274611	.5181347
COL AVERAGE		.1722798	.2655440	.1448187	.3044041	.2310861
SIGMA1 SQ		.0184858	.0286726	.0035949	.0088509	.0305131
SIGMA1 SQ AVG		.0180673				
OVERALL AVG		.2436269				
SIGMA2 SQ 1		.0094233				
SIGMA2 SQ 2		.2967704				
SIGMA2 SQ 3		.0117791				

F RATIO: .6541298

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
CENTRAL REGIONAL LABORATORY
839 BESTGATE ROAD
ANNAPOLIS, MARYLAND 21401

301-224-2740
FTS-922-3752

DATE : January 15, 1987

SUBJECT: Pesticide Analysis - Leetown, W. Va.
Superfund-Remedial, (12/11/86 - 1/9/87), 861211-01 - 12

FROM : S. R. Kayser
Chemist

TO : John Austin
Acting Chief, Annapolis Laboratory

Samples were soxhlet extracted and analyzed for pesticides.

Sample Description:

Lab No.	Description
861211-01	Leetown, W. Va., NS-4-R-A-2
-02	Leetown, W. Va., NS-7-R-A-1
-03	Leetown, W. Va., NS-7-I-AN-4
-04	Leetown, W. Va., NS-4-R-A-5
-05	Leetown, W. Va., NS-7-I-AN-1
-06	Leetown, W. Va., NS-7-I-AN-5
-07	Leetown, W. Va., NS-7-R-A-2
-08	Leetown, W. Va., NS-7-R-A-4
-09	Leetown, W. Va., NS-7-I-AN-2
-10	Leetown, W. Va., NS-4-R-A-4
-11	Leetown, W. Va., NS-4-R-A-1
-12	Leetown, W. Va., NS-7-R-A-3

QA Check:

Breakdown DDT <10%
Breakdown Endrin <20%

SRK:ad

cc: Peggy Zawodny
QCO

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
CENTRAL REGIONAL LABORATORY
839 BESTGATE ROAD
ANNAPOLIS, MARYLAND 21401

301-224-2740
FTS-922-3752

DATE : January 16, 1987

SUBJECT: Pesticide Report for Leetown, WV.

FROM : John Austin (3ES21) JA
Acting Chief, Annapolis Laboratory

TO : Laura Boornazian (3HW21)

Enclosed is the pesticide report for Leetown, WV. If you have any questions, you can contact Rosemary Kayser directly.

JA:jr

Enclosure
a/s

Project Name: Leetown, W. Va. - Superfund-Remedial

Sample Number:		861211-01	Duplicate 861211-01	861211-02	861211-03	861211-04	861211-05
		ppm	ppm	ppm	ppm	ppm	ppm
PESTICIDE							
Parameter	Cas Number						
4,4'DDD	72-54-8	1.0	1.4	1.0	6.1	0.9	7.8
4,4'DDE	72-55-9	1.2	1.6	2.0	1.3	2.0	1.6
4,4'DDT	50-29-3	21.6	21.7	29.2	1.3	29.0	3.7
1,4'DDD		0.4	0.4	0.4	0.7	0.4	1.2

Sample Number:		861211-06	861211-07	861211-08	861211-09	861211-10	861211-11
		ppm	ppm	ppm	ppm	ppm	ppm
PESTICIDE							
Parameter	Cas Number						
4,4'DDD	72-54-8	8.8	1.5	1.5	14.9	1.1	1.6
4,4'DDE	72-55-9	1.4	1.8	2.7	2.7	2.7	2.7
4,4'DDT	50-29-3	2.4	32.9	32.7	3.2	28.2	39.3
1,4'DDD		0.7	0.4	0.4	1.4	0.6	0.5

Sample Number:		861211-12	Blank	Reagent Spike Average % Recovery
		ppm	ppm	
PESTICIDE				
Parameter	Cas Number			
Aldrin	309-00-2	---	N.D.	100%
4,4'DDD	72-54-8	0.7	N.D.	90%
4,4'DDE	72-55-9	1.6	N.D.	91%
4,4'DDT	50-29-3	21.8	N.D.	82%
1,4'DDD		0.4	N.D.	89%
Heptachlor	76-44-8	---	N.D.	93%

N.D. = None Detected

PESTICIDE/PCBS PRIORITY POLLUTANT COMPOUND DETECTION LIMITS

Parameter	Cas Number	Soil/Sediment mg/kg
Aldrin	309-00-2	0.03
Alpha BHC	319-84-6	0.02
Alpha Endosulfan	959-98-8	0.05
Beta BHC	319-85-7	0.04
Beta Endosulfan	33213-65-9	0.1
Chlordane	57-74-9	0.4
4,4'DDD	72-54-8	0.12
4,4'DDE	72-55-9	0.06
4,4'DDT	50-29-3	0.16
1,4'DDD		0.02
Delta BHC	319-86-8	0.04
Dieldrin	60-57-1	0.06
Endosulfan Sulfate	1031-07-8	0.3
Endrin	72-20-8	0.09
Endrin Aldehyde	7421-93-4	0.23
Gamma BHC (Lindane)	58-89-9	0.02
Heptachlor	76-44-8	0.02
Heptachlor Epoxide	1024-57-3	0.04
Toxaphene	8001-35-2	4.0
PCB 1016	12674-11-2	0.4
PCB 1221	11104-28-2	1.0
PCB 1232	11141-16-5	1.0
PCB 1242	53469-21-9	0.5
PCB 1248	12672-29-6	0.8
PCB 1254	11097-69-1	0.8
PCB 1260	11096-82-5	1.5

NUS CORPORATION
SUPERFUND DIVISION

CHAIN OF CUSTODY RECORD
REM/FIT PROJECT

PROJECT NO.:	WORK PLAN NO.:	SITE NAME:
3724.01		LEE TOWN, W.VA

SAMPLERS (SIGNATURE): Debra A. Schultz

STATION NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	4 drams	8 drams					REMARKS	
	12/8			L	NS-4-R-A-2	1	1						FULL HSL	86121101
	12/8			L	NS-7-R-A-1	1	1						FULL HSL	86121102
	12/8			L	NS-7-I-AN-4	1	1						PESTICIDES	86121103
	12/8			L	NS-4-R-A-5	1		1					PESTICIDES	86121104
	12/8			L	NS-7-I-AN-1	1		1					PESTICIDES	86121105
	12/8			L	NS-7-I-AN-5	1		1					PESTICIDES	86121106
	12/8			L	NS-7-R-A-2	1		1					PESTICIDES	86121107
	12/8			L	NS-7-R-A-4	1		1					PESTICIDES	86121108
	12/8			L	NS-7-I-AN-2	1		1					PESTICIDES	86121109
	12/8			L	NS-4-R-A-4	1		1					PESTICIDES	86121110
	12/8			L	NS-4-R-A-1	1		1					PESTICIDES	86121111
	12/8			L	NS-7-R-A-3	1		1					PESTICIDES	86121112

RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
Debra A. Schultz	12/9/86 1050	Mark L. Mengel			
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):
Mark L. Mengel	12/9/86 1200	Airb. 11 # 248 741 883			
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE/TIME:	REMARKS:	
		James Robertson	12-11-86 0732		

Distribution: Original accompanies shipment, copy to coordinator field files

NUS 440 58 1082

No. 04260

NUS CORPORATION

Park West Two
Cliff Mine Road
Pittsburgh, PA 15275
412-788-1080

January 22, 1987
NUSP/87-0035
NA

Ms. Laura Boornazian
Remedial Project Manager
U.S. Environmental Protection Agency, Region III
814 Chestnut Street
Philadelphia, Pennsylvania 19107

Subject: REM III PROGRAM - EPA CONTRACT NO. 68-01-7250
LEETOWN PESTICIDE SITE, WEST VIRGINIA
EVALUATION OF PRESENT STATUS

Dear Laura:

As we had discussed on January 20, I believe that a meeting between the EPA, Ebasco Services, and NUS Corporation is required in the near future to formally evaluate the results of the bench scale microbial degradation treatability study and to establish direction to proceed with the studies. We would prefer to schedule such a meeting in early February, if possible.

As a result of the work done since last June, and particularly based on the results from the fourth round of sampling in December 1986, NUS feels that the indigenous microbial population can be utilized in reducing DDT concentrations in Leetown soils. While we originally based our evaluation of the health threats associated with these contaminated soils on inhalation of fugitive dusts by farmers plowing the soil, we believe that a toxicity test (e.g., Ames Toxicity Test) and full, replicate Hazardous Substances List (HSL) scans should be run on the soils from the anaerobic, incubated cells at this point. If the soils prove to be non-toxic, and no HSL parameters are found that could give rise to excess health risk, then we can utilize the DDT risk-based action levels established in the Remedial Investigation Risk Assessment as the criterion for evaluating the success of the microbial degradation.

As you will recall, we did note in our phone conversation that the formerly incubated cells have been held at room temperature since mid-December due to a malfunction of the incubator. While this development may affect the reaction rate in these cells, the DDT action levels had been achieved through mid-December, and the fact that the cells are not presently being incubated should not adversely influence their amenability to further chemical analysis.

We do not believe that the treated soils will prove to be toxic, and, indeed, may not have tested so prior to treatment. We also do not believe that HSL scans of the treated soils will evidence

any metabolites of DDT that would pose a greater health risk than that present due to the pesticides. To support this, no peaks were evident on the chromatograms between DDT and DDE, indicating few, if any, metabolites present in the samples with similar molecular weights to DDT and/or DDE.

At the Region's request, we had considered the possibility of conducting a study using radio-labeled (C-14) pesticides to assist in determining the degree to which the DDT present in the original soil is completely mineralized to carbon dioxide and water. However, the bench scale study has demonstrated the ability of the microbes to reduce pesticide levels in the soils, and if the treated soils do not evidence any toxicity we believe that the C-14 study at this point would be somewhat academic.

The basic premise for the study is that labeled CO_2 off-gas can be trapped on an adsorbent medium replaced at periodic intervals. By counting the activity of the adsorbent material, quantification of the mineralization can be achieved. We are aware of several difficulties with conducting this study that may affect the results. In particular, the study may not be sensitive to evaporative losses of labeled pesticides from the soil, resulting in their contaminating the adsorbent material and artificially elevating activity. It would not be possible to quantify the degradation via mass balance, since we would be adding a known quantity of labeled pesticide to an already contaminated medium, i.e., the Leetown soils. Use of Leetown soils may be crucial to the success of the degradation, since indigenous microbes appear to be successful in degrading the DDT. A calculated quantity of labeled pesticide material must be added to the soil to ensure that enough mineralization occurs to produce measurable activity levels. This additional pesticide contamination may have an adverse impact on the microbes.

We would like the opportunity to discuss the utility of the C-14 Study in the light of the most recent bench scale results. If we elect to proceed with the toxicity tests and HSL scans, and the results are as expected, we feel that immediate plans should be made to establish a more controlled bench scale study, in parallel with a pilot scale test of the technology at the Leetown Site. Such a meeting is not presently within our scope of work. An amendment to our Work Assignment, which would provide the

funds to develop a Work Plan to pursue the C-14 Study, is currently pending Ebasco authorization. As we had suggested during our phone conversation, a portion of these funds would be better used at this time to conduct a project meeting prior to further work. You had indicated that you would consider this approach, and advise Ebasco accordingly. We will await your direction before proceeding.

Very truly yours,

John A. George
Project Manager

JAG/jag

cc: E. Shoener (EPA Region III)
R. Evans (Ebasco)
W. Mendez (Ebasco)
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